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A Landscape and Materials-based Approach to Royal Mortuary Architecture in Early Third Millennium BC Egypt

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I, Tessa Dickinson, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

This dissertation examines the role that the building of royal mortuary complexes (RMC hereafter) played in the consolidation of the Egyptian state between the reigns of kings Khasekhemwy and Shepseskaf, c. 2,700-2,500 BC. The theoretical basis for this research is inspired by cross-cultural studies that demonstrate (a) that monuments are not only the after-effect of a centralised state system, but may themselves be integrative strategies that contribute more directly to a state's formation and consolidation and (b) that a monument's location and construction materials reflect both logistical and symbolic concerns with salient socio-political scope. The main analysis offered here consists of a sequential, monument-by-monument archaeological assessment of RMC location and construction materials with a particular emphasis on the role of a specialist workforce. This research combines both quantitative and qualitative methods that help flesh out possible logistical and symbolic implications associated with the decision-making process behind each RMC. The working and symbolic properties of a whole range of construction materials is determined via careful use of the limited contemporary, and more abundant later, Egyptian documentary sources, as well as demonstrable patterns of material use in the archaeological record. A geoarchaeological analysis of mudbrick provides an important category of additional information on the sourcing of mudbrick and the labour organisation, which has received only limited attention. A locational and materials-based approach brings together a wealth of complementary information pertaining to the functional and symbolic aspects of these monuments, and their wider landscapes that is usually treated separately and selectively. It also provides the tools necessary for addressing the use of mudbrick in architecture during this early period and a well-known shift from mudbrick to stone in RMCs. Overall it provides a more dynamic and holistic framework for understanding the role that monumental building played in this early period of the Egyptian Pharaonic state.

Table of Contents

Volume 1

Volume 2

List of Figures

List of Tables

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CHAPTER 1
INTRODUCTION

1.1. Introduction to Research and Project Background

The royal tombs of the Old Kingdom are one of the most conspicuous features of the Egyptian landscape and, as a result, they have received and continue to receive much attention (fig. 1.1; O'Connor 1992). Discussions of royal tomb architecture predominantly consider the stone-built tombs of the Old Kingdom, providing us with valuable insights into the society that built them. They also tend to see these tombs as an entirely separate group from those of the preceding Early Dynastic, which employed mostly mudbrick and were less obvious in the Egyptian landscape. This fact has encouraged a strong sense of rupture between the two periods that limits our understanding of the transition between the two phases and of subsequent developments in royal tomb-building activities. Discussions also tend to focus on the finished structures and see them as elite displays of conspicuous consumption. In so doing, they have deliberately or inadvertently encouraged an understanding of these monuments as a passive symptom of the state and of the society that built them as a top-down, pyramid-like structure (Bloxam 2004). Yet there are other studies that have, in contrast, shown that such monuments are not a prerogative of states and that they have very strong structuring potential, creating, not just reflecting, complex power dynamics. This thesis offers a more contextual method of assessment of the logistical, symbolic and social implications attached to the building of these monuments over a fuller time-span and in an explicitly sequential way.

The monuments considered in this study were built during a period of political transition after the state's initial formation (from c.3,100-2,700 BC; see Appendix A for chronology) and during which the Egyptian state was developing into a more consolidated political system. In historical terms, this shift is marked by the end of the Early Dynastic and the beginning of the Old Kingdom (hereafter ED and OK respectively), covering c.200 years between 2,700 and 2,500 BC. Developments in material use, symbolism and crafting during this period are particularly visible in the archaeological record. However, developments in royal mortuary complexes (hereafter

RMCs) have never been addressed in a systematic way across the full sequential range of royal monuments and the full spectrum of both location and construction materials. This dissertation challenges the assumption of a sharp shift from a mudbrick to a stone-dominated royal architecture. In fact, evidence shows that there is much more of an interplay between the use of these two materials in royal funerary architecture throughout a longer period of political consolidation. The depth of existing research on these monuments makes them an ideal basis for combining landscape archaeology, sequential study of the monuments and multi-material analysis to help re-contextualise and re-assess the role these structures played in the changing society that built them. By assessing the choices made with regard to construction material, landscape and workforce during the building of royal tombs, the structuring role of royal tomb-building activities is made more accessible and offers a good counterbalance to a traditional focus solely on the elite, one that encourages a view of interaction between them and the rest of the population.

1.2. Research Aims and Scope

The overarching aim of this research is to better understand the role RMCs played in the early Egyptian society that built them. Therefore, the main question it seeks to answer is this: what do changes in the location and construction materials of Egypt's royal mortuary complexes tell us about socio-political change and, in particular, the consolidation of power during the early 3rd millennium BC?

The majority of the RMCs with which this study is concerned are in the north, covering a 75 km stretch north and south of modern day Cairo and include six major sites, which are, from north to south: Abu Rawash, Giza, Zawyet el-Aryan, Saqqara, Dahshur and Meydum. To understand the significance of RMC building over time, and in particular what changes in location and construction materials can tell us, these monuments are considered sequentially, monument by monument, over the 200-year period that marks the end of the ED and earlier part of the OK (dynasties 3 and 4). The observed patterns are discussed in terms of their practical, social and symbolic implications as a means to access the possible role the construction of these monuments may have played in the construction and consolidation of the state (DeMarrais *et al.* 1996). It is worth noting from the outset that there is some difficulty associated with identifying the exact sequence of rulers and the exact attribution of different monuments to specific rulers. Given this thesis' desire to explore some of the intentions behind specific material and locational choices, these problems will need to be tackled head on in the chapters that follow. While many of these academic debates of timing and attribution have been resolved (Lauer 1962a; Edwards 1994; Seidlmayer 2006; Verner 2006), making it possible to consider engaging in a diachronic discussion of RMCs in the first place, some remain and these are mentioned in the relevant sections of this thesis, with alternate scenarios offered where necessary. The historical chronology used here is from O'Connor 2009 (see Appendix A). Also, a note should be made regarding the use of the terms 'monuments' and 'architecture'. Architecture is originally an umbrella term that refers to all types of human construction, both public and domestic, and monument refers to a specific structure, in our case with a certain sense of scale and a strong ritual and commemorative function. Because the corpus of architectural studies provides useful theoretical and methodological tools for assessing the architectural remains of RMCs, the terms 'monument' and 'architecture' are often used interchangeably though the thesis.

1.3. Outline of Thesis, Data Illustration and Appendices

The thesis is divided into three main sections. Part One introduces the study, with an overview of the history of research on RMCs in Chapter 2, followed in Chapter 3 by a more in depth treatment of these issues and particular emphasis on the wealth of literature on pyramids, the background review focuses on major trends in funerary practices with regard to location, material selection and the workforce. Chapter 4 then turns to a consideration of a variety of useful theoretical frameworks and explores cross-cultural perspectives on monumentality, political ideology, materiality and the landscape. Part Two begins by explaining the methods of analysis provided in Chapter 5 and offering a review of the available data. It then goes into greater detail for the first ruler, Khasekhemwy, to make up for the fact that there is less existing treatment of his monuments in Chapter 6, before considering the important developments of the subsequent 3rd and 4th dynasty in Chapters 7 and 8. Part Three offers a discussion of the main results of this detailed analysis and some of their possible logistical, socio-political and symbolic implications in Chapter 9, followed by a brief conclusion and prospects for future work in Chapter 10. The references cited in the text are provided at the end of Volume 1; illustrations, databases and appendices are given in Volume 2.

CHAPTER 2
HISTORY OF RESEARCH

Royal mortuary complexes (RMCs) are a well-studied group of monuments. This is especially true of OK examples as these have been repeatedly used to illustrate the role of kingship in the formation and consolidation of the early Egyptian state (Lauer 1957; Fakhry 1969; O'Connor 1974; Kemp 1989; Roth 1991; Baines 1995, 1997; Hawass 1995; Wilkinson 1999, 2004; Malek 2000; Wengrow 2006). This chapter summarises current understandings of RMCs with regard to the role they played in early Egyptian society and outlines some existing biases in emphasis that subsequent chapters will seek to address. Most studies of RMCs are based on an assessment and discussion of architectural features, such as shape, size, layout and decoration and many attempts have been made to relate changes in architecture with changes in worldview, religion and politics (O'Connor 1974: 18; Baines 1995: 142). More recently, there has been some limited discussion of the location of these monuments, mainly for the OK RMCs that systematically change site. In contrast, very little has been said about material selection and patterns of use of materials, with materials generally talked about only with reference to the stone workforce called upon for these building projects. Moreover, mudbrick RMCs have received little attention compared to their later stone counterparts. This chapter discusses the pros and cons of existing research on RMCs and, because of the importance of reign-by-reign comparison in what follows, it ends by critically reviewing our current understanding of the sequence of RMCs and the attribution of particular monuments to particular rulers.

2.1. Overview of Major Trends in Early Funerary Architecture

The wealth of site reports on RMCs highlight a long-lasting fascination with these monuments, which has provided valuable data for discussions of RMCs. It is generally understood that RMCs held a central place in Egyptian society (Lauer 1957; O'Connor 1974; Kemp 1989; Roth 1991; Baines 1995, 1997; Hawass 1995; Wilkinson 1999, 2004; Malek 2000; Wengrow 2006). The OK is commonly coined the Pyramid Age, with the 4th to 6th dynasty RMCs often considered as the "quintessential expressions of ancient Egyptian civilisation" (Wilkinson 1999: 1129). RMCs are often used as a means by which to understand wider issues in ED and OK society.

Early commentators chose to focus primarily on the taxonomy of RMCs, emphasising shape, layout and size. This section offers a brief overview of our current understanding of the design of RMCs built in early Egypt during the ED and OK to offer wider points of reference for (a) a review of how commentators have used these aspects to discuss the role RMCs played in early Egyptian society, and (b), the discussion offered in later chapters regarding specific trends and developments visible in RMCs built between 2,700-2,500 BC. While this section retains a focus on royal mortuary architecture, further developments in the private tombs of the wider elite and poorer segments of society are also briefly discussed for comparative purposes.

It is generally understood that throughout the ED and Pharaonic period in Egypt, tombs, especially elite ones, fulfilled two functions; they were a burial place and a place designed to receive offerings for the deceased (Reisner 1936: 6). Therefore, elements of a tomb's design are thought to reflect both the personal perspectives of the deceased and a wider belief system. Substructures (the subterranean parts of the tomb) are better preserved and have therefore been studied more systematically. Superstructures, in contrast, are more often missing from the archaeological record, particularly for the ED RMCs at Abydos in the south and Saqqara in the north of Egypt. These differences in archaeological recovery have interpretative consequences that will need to be kept in mind for the summary below and for discussion presented in later chapters.

The Predynastic

Burial customs during the Predynastic Naqada I and II periods exhibit consistency over a fairly long period, with the main chronological difference being greater wealth disparity visible among different tombs towards the end of Naqada II. Cemeteries are typically located in the low-lying desert, often in wadis or wadi palaeofans close to settlements on both banks of the Nile Valley. The earliest tombs (Badarian and Naqada I; 5,500-3,850 BC) are simple oval or circular pits cut in the desert gravel, generally without a superstructure. A few are marked with a small mound of rubble from the pit excavation (Davies and Friedman 1998: 57). Near settlement, low-lying tombs occasionally marked by a mound remained the standard style of tombs for the poorer segments of society throughout the Predynastic and Dynastic phases, but the focus below will be on variability exhibited by the more elaborate funerary structures belonging to the ruling elite.

By Naqada II (3,850-3,300 BC) certain tombs had become rectangular, some starting to show increases in size and complexity of design, indicating an increasingly stratified society, a phenomenon that accelerates during the subsequent period of ED state formation, and even more dramatically in the OK (Bard 1994; O'Connor 2009: 148). A number of tomb pits built by wealthy individuals are lined and roofed with wood, and those belonging to the wealthiest are lined with mudbrick, occasionally using partition walls to create subterranean chambers. Tomb 100 at Hierakonpolis, the largest tomb for the Naqada IIa/b period, had mud-plaster coated walls painted with yellow ochre with one wall entirely decorated with scenes of hunting or smiting the enemy, scenes which later became part of the Egyptian ruling elite's canon of representation, and a superstructure built with wood and reed (fig. 2.1; Case and Payne 1962). Cemetery U at Abydos on the west bank of the Nile, in the south of Egypt, was most certainly where the ancestor chiefs, possibly 17 of them associated with the rulers who later united Egypt in 3,100-3,000 BC, were buried (fig. 2.2; Dreyer 1992; Dreyer *et al.* 1998; O'Connor 2009: 141). Tomb U-j is one of the earliest and largest of this ensemble (9.1 x 7.3 m; fig. 2.3). It was cut in the desert gravel and built with mudbrick, has twelve rooms, the biggest being the burial chamber that contained a wooden shrine. Tombs at Hierakonpolis and Abydos already show a preference for a west bank location and connection with the local wadi. From the earliest stages of this more elaborate funerary tradition, tomb construction materials, layout, and location are linked with the ruling elites' public expressions of ideologies of power (Kemp 1989: 53-63; Bloxam 2004: 107).

The 1st Dynasty

In the subsequent period (Naqada III/ Dynasty 1 3,100-2,890 BC), the disparity between the rich and poor becomes greater than ever, with elite tombs increasing in both size and complexity (Reisner 1936: 5-6). The first royal cemetery, Cemetery B, was established at Abydos and, together with earlier Cemetery U to the north of it, the two cluster areas form the first royal necropolis. The royal funerary structures of this period demonstrate further increases in monumentality and, together with other forms of ceremonial display such as the *Heb-Sed* or the running of the wall (Bleeker 1967; Park 1998) are thought to have been ceremonial displays meant to legitimise the king's right to rule (Hoffman 1991: 335).

While the 1st dynasty RMCs at Abydos have greatly suffered from plunder and destruction from antiquity onwards, (O'Connor 2009: 148), the evidence indicates that they consisted of two physically separate architectural units, a tomb and an enclosure (fig. 2.4). The two features are connected by a natural route formed by the local wadi's dry riverbed that links the royal tombs a few 100 m east from the wadi entrance at the foot of the desert cliffs to the enclosures 2 km east by the cultivation and settlement area (O'Connor 2009: 136). There are hardly any traces remaining of the 1st dynasty royal tomb superstructures at Abydos (O'Connor 2009: 151). From Djer onwards, the available evidence suggests that they consisted of low mounds of sand below the original desert surface, lying under an even layer of undisturbed sand, making the mounds invisible to the naked eye; those of Djer and Djet were square and those of Den, Semerkhet and Qa'a, rectangular (fig. 2.8; Petrie 1900, 1901; Dreyer 1990; Dreyer *et al.* 1992, 2003). The last royal tomb built at Abydos, which belonged to Khasekhemwy, the last ruler of the 2nd dynasty and the first king considered in detail by this research, had a low mound-like structure built above his substructure. The visible part of the superstructure could have been either flat-topped or formed of a single low step (fig. 2.8; O'Connor 2009: 152). Perhaps a reed and wood structure was built, as was the case for Naqada III tombs at Hierakonpolis (Garstang 1907; Adams 1996). The mound had a funerary purpose but was not yet the visible marker it later became with the Old Kingdom pyramids. Though none were found *in situ,* pairs of stone stelae bearing the king's name in a *serekh* are likely to have marked the tomb's location (O'Connor 2009: 151-2).

Today, only the tomb substructures remain, which are deliberately more grandiose elaborations of the Predynastic ones, especially of the tombs found in Cemetery U. Pits in the form of large open trenches were cut into the desert gravel and lined with mudbrick (see fig. 2.5, tomb of Djer as an example). Chambers and storerooms surround the burial chamber that contained a wooden shrine where the king's coffin was probably placed. The walls were covered with mats of woven organic material and the substructure was roofed with wooden beams and covered with layers of mudbrick, sand and gravel. Subsidiary graves were also placed around the tombs (Bestock 2008: 43; O'Connor 2009: 149). A good example of a 1st dynasty royal tombs is Aha's which was built south of three smaller tombs of his predecessors (fig. 2.6; O'Connor 2009: 141) and was approximately five times the size of the largest tombs in Cemetery U. The substructure was built in several stages, as is customary with all Abydos RMCs, and consists of three separate square subterranean chambers with separate mudbrick magazines (storerooms) that extend in three rows northeast of his tomb (Dreyer *et al.* 1992). Aha's tomb, like other royal tombs in the 1st dynasty, was surrounded by 34 burials for personnel that had been killed probably at his death, a practice abandoned by the end of the 1st dynasty (Dreyer 1990: 68). Tombs of the subsequent kings develop in a south-west direction towards the wadi and appear as variations on the initial theme, with burial chambers cut deeper into the ground, the wooden shrine fitted increasingly closely to the mudbrick wall, pushing the magazines outwards. A space was systematically left in the south-west corner of the subsidiary graves or magazines, leaving a sight-line and passage between the tomb and wadi (Wilkinson 1999: 238). Den, 5th king of the 1st dynasty, was the first king to use stone in the form of a red and black granite pavement laid on a limestone foundation (fig. 2.7; Amélineau 1899: 124-5; Petrie 1901: 10-1; Dreyer 1990: 76-7; Dreyer *et al.* 1998: 142-8).

Of the eight known royal enclosures found at Abydos, only the foundations remain for all but that of the last ruler to be buried at Abydos, king Khasekhemwy (figs. 2.4, 6.12). While two enclosures remain unassigned, four have been ascribed to the first four rulers of the 1st dynasty, kings Narmer, Aha, Djer and Djet, and two to the last two rulers of the 2nd dynasty, kings Peribsen and Khasekhemwy (Bestock 2008: 44). The enclosures follow a northeast-southwest orientation, and their overall proportions vary, as do the width of the walls. Their heights are unknown, but probably also varied (Bestock 2008: 44). The walls were coated with mud-plaster and their exterior decorated with simple recessed niches. The northeast wall is more elaborately decorated. A small mudbrick chapel is occasionally found in the southeast quadrant of the enclosure near the main entrance and a smaller entrance near the northern corner were bricked up soon after completion, turning the entrance into a deeper niche and leaving the eastern entrance as the sole entry point to the structure (fig. 2.9; Bestock 2008: 46). By the 2nd dynasty the trends are reversed and the northern entrance becomes the main point of entry (O'Connor 1989; Adams and O'Connor 2003: 84; Bestock 2008: 44-5). All 1st dynasty enclosures had subsidiary graves around them, similar to those found near the royal tombs. Unlike the tombs, the enclosures appear to have been built as temporary structures, as they show signs of having been brought down deliberately, probably at the time of the king's death or during his funeral, which explains why only the foundations remain (Adams and O'Connor 2003: 84; Bestock 2008: 47). This possibility will be discussed further in Chapters 5 and 8 in connection with Khasekhemwy's enclosures.

The poor state of preservation of the enclosures makes it difficult to determine their function, as will be discussed in greater detail in Chapters 6 and 9 (O'Connor 1989; Adams and O'Connor 2003; Bestock 2008). Archaeologists term them funerary enclosures as one is known for almost each king of the ED buried at Abydos and they are found close to the tombs, to which they are physically connected by a processional way (O'Connor 2009: 136). Some commentators suggest that the enclosures are replicas of the royal residence intended for rituals pertaining to the king's mortuary cult, making them symbols of royal power (Kemp 1966: 16, 1989: 55; O'Connor 1995: 328). If so, the chapel was probably central to these events, something that the offering remains from this area seem to confirm (Adams and O'Connor 2003: 84; Bestock 2008: 46). In light of evidence from the early temple mound at Hierakonpolis, it has recently been suggested that the rituals may not only relate to royal funerary practice, but also to rituals pertaining to the living king, such as the *Heb-Sed* festival, a celebration and reaffirmation of the king's claim to rule during his lifetime (McNamara 2008; Regulski 2009: 227). It seems very likely that the enclosures defined some kind of sacred space, and that their increase in surface area over time reflected an increase in the scale of the activities taking place within these structures (Bestock 2008: 47).

Like their royal counterparts, the tombs used by elite private (rather than royal) individuals of the 1st dynasty also become more complex. Two types of substructures exist, probably reflecting differences in local geology: an open pit type generally included a burial chamber in the pit and the magazines inside the superstructure for softer types of bedrock, while a shaft type had the chamber underground cut deeply into the bedrock, with the most prestigious ones having several chambers, for harder bedrock (Dodson 2001: 435). The tomb interiors were mudbrick-lined and roofed with wood. Mastabas (the term is a modern Arabic one evoking their bench-like shape) are built on top of most tombs and were completed after burial by building masonry faces and filling the core with rubble up to the height of the superstructure's external face (fig. 2.9; Bard 2000: 76). In earlier periods the mastaba superstructure contained rooms built around a central mound of masonry-encased rubble core that covered the substructure, but subsequently, mastabas' superstructures became solid and the storerooms were placed underground, probably to protect them from looting. Mastabas first appear at Naqada and Saqqara, with the latter having the highest concentration. The refinement of the design and engineering, prominent location, and wealth of burial goods indicate that the Saqqara mastabas of the 1st dynasty belonged to high court officials (Emery 1949, 1952, 1958; Kemp 1967; Tavares 1999; La Loggia 2009). Similar mastabas are also found at Tarkhan, Giza and Naga el-Deir (Petrie *et al.* 1913; Petrie 1914; Reisner 1931; Bard 2000: 76). Their rectangular shape and common palace-facade exterior make them appear as solid versions of the royal enclosures at Abydos, the only difference being that mastabas were built above the substructure, bringing tomb and enclosure into a single architectural unit. The design of the mastaba superstructure is very much connected with the royal residence (La Loggia 2009).

The 2nd Dynasty

From the start of the 2nd dynasty, Egyptian kings largely left Abydos and chose to be buried in the north of Egypt, 1 km south of the 1st dynasty elite tombs at Saqqara that overlooked the new administrative capital Memphis and across the valley from an important east bank ED cemetery at Helwan (fig. 2.10; Van Wetering 2004: 1058). Although the succession of kings is unclear for the 2nd dynasty, seven kings are usually recognised, five of whom are thought to be buried at Saqqara, with the last two returning to Abydos (see Appendix A; Dodson 1996). In sharp contrast with the open-trench substructure tombs dug and built in the wadi palaeofan at Abydos, the Saqqara tombs consist of expansive networks of subterranean rock-cut galleries and chambers shown to mimic the royal residence (figs. 2.11, 2.12; Munro 1993: 49; Lacher 2011). The outer passages are roofed with slabs of limestone and blocked with limestone portcullises; the burial chamber is to the south (Barsanti 1901: 183; Van Wetering 2004: 1066). A third tomb found with seals with Khasekhemwy's name either belonged to a member of the royal family or to a 2nd dynasty high official, in which case the tomb could be indicative of a contemporaneous, private cemetery on the Saqqara plateau in addition to the royal tombs (Regulski 2009: 226). The layout and design of the system of galleries under the eastern part of Djoser's tomb suggest that the galleries too were originally part of a structure of this type, potentially a fourth tomb dated to the 2nd or the start of the 3rd (Kaiser 1969; Stadelmann 1985).

The superstructures of the 2nd dynasty RMC at Saqqara are almost wholly missing, but traces of a two-part superstructure were found above Hotepsekhemwy's substructure

(Munro 1993: 49). The northern section, which may have been a courtyard, consists of a flattened area 20 m long, coated with mud-plaster. South of it is a step-like feature cut into the bedrock (1 m high) that runs east-west directly above the imaginary line that separates the private area of the substructure from the public area to the north. Although evidence is lacking, the 2nd dynasty superstructures at Saqqara may have been just as substantial as the later 3rd dynasty ones, and reused to build Djoser's complex to the north (Munro 1993: 52-4). Two large structures to the west, a mudbrick enclosure commonly known as the L-shaped feature and the monumental limestone enclosure known as the Gisr el-Mudir discussed in greater detail Chapters 5 and 8, further support the possibility (fig; 2.13; Mathieson *et al.* 1993, 1997; Mathieson and Tavares 1993: 27-8; Dodson 1996: 24; Mathieson 2000: 37; Van Wetering 2004: 1069).

The last two rulers of the 2nd dynasty, Peribsen and Khasekhemwy, returned to Abydos and built their mudbrick tombs and enclosures amongst those of the 1st dynasty kings (figs. 2.14). Peribsen's substructure consists of a mudbrick-lined pit and is consistent with the design of the 1st dynasty royal tombs (fig. 2.15). Khasekhemwy's is discussed in greater detail in Chapters 5 and 8. Although the reasons for returning to Abydos remain unclear, Peribsen's tomb at Abydos is often described as a break with the Memphite tradition, and a return to the traditional RMCs at Abydos as a sign of a political strife that may have caused the northern and southern territories to fissure at some point in the 2nd dynasty, a topic returned to in Chapter 6 (see O'Connor 1989: 84; Wilkinson 1999: 91-2; Friedman 2007: 328).

Most 2nd dynasty private tombs depart from the open-trench tombs of the 1st dynasty by following a similar but smaller and less complex design than the contemporary RMCs, and one that seems to become more compact over time (Reisner 1936: 3-14; Van Wetering 2004). Still, a great variety in design is visible, particularly at Helwan, where some more elaborate tombs were stone-lined, perhaps in an effort to mimic the royal tombs (Köhler 2000, 2004, 2008). Mastabas continue to be used for superstructures of the wealthier private tombs. Unlike the earlier examples, the mastabas of the 2nd dynasty are now solid and no longer contain magazines (Dodson 2001: 435).

The 3rd and 4th Dynasties

The 3rd and 4th dynasties see major developments in royal tomb location and design. As these form the focus of discussion in subsequent chapters, they are only very briefly reviewed here to provide continuity in discussion. The 3rd dynasty marks the notional beginning of the OK, a period of intense political consolidation and expansion. It is characterised by the royal cemetery's permanent return to the capital region in the north and a shift in focus from the complex substructures to very visible superstructures, which remain the focal point for all royal funerary building activity until the end of the OK (fig. 2.16). Building was confined solely to a stretch between Abu Rawash in the north and Meydum in the south. A strategy of systematic change in construction site from one ruler to another was introduced early in the 3rd dynasty and maintained until the end of the 5th dynasty (Goedicke 2000). The start of the 3rd dynasty ushered in an age of large-scale stone consumption, which peaked in the 4th dynasty in terms of volume and range of stones (Wilkinson 1999: 230-47; Goedicke 2000: 398). Djoser, commonly considered the founder of the 3rd dynasty, established the main components for all subsequent RMCs by bringing together enclosure and tomb, introducing the pyramid shape, which becomes characteristic of all OK RMCs, and the use of systematically shaped masonry blocks which progressively become larger until the end of the 4th dynasty (Lauer 1957; Kaiser 1969: 6). Snefru, the founder of the of the 4th dynasty, is thought to have introduced a new east-west axis, the idea of a 'perfect' un-stepped pyramid with a mortuary temple on its east side and a valley temple at the edge of the cultivation connected to the upper portion by means of a causeway (Stadelmann 1980, 1983). Snefru also introduced the pyramid cemetery, whereby members of the royal family and upper elite were buried around the king's tomb, initially at a distance but rapidly coming closer (Roth 1991).

While royal architecture shifted to stone pyramids, private tombs of the 3rd dynasty continued to favour mudbrick mastabas. Both solid mudbrick masonry, introduced in the 2nd dynasty, and simple masonry-faced rubble cores coexist. The exteriors are plastered and whitewashed. Substructures continue with the tunnels and galleries, and the shaft system was increasingly used to build the burial chamber, around which were storerooms (Garstang 1903). In the 4th dynasty, stone was introduced alongside mudbrick, as the private tombs at Dahshur and Giza demonstrate (Porter and Moss 1974). As with the royal tombs, some private tombs were built with solid stone masonry, with progressively larger blocks used in construction; the offering area also became more conspicuous (Bárta 1998). The lower section of a number of superstructures of the later part of the 4th dynasty is partially rock-cut, while substructures became simpler, rock-cut and accessed by a shaft. The majority of the tombs known for this period come from the Memphite region (Bárta 1998).

2.2. The Role of RMCs in Early Egyptian Society

It is generally accepted that RMCs were originally built as a burial place for kings and were designed to ensure kings' resurrection in the afterlife (Edwards 1993: 278; Wilkinson 1999: 255). The design of ED royal tombs demarcates itself from private tombs in that they were replicas of the royal residence, providing the king with everything he might need in his afterlife (Baines 1995: 138; Walsem 2003; Regulski 2009). By the 3rd dynasty – the start of the OK – it is argued that Djoser's RMC brings together the respective funerary ideologies of the north and south by bringing together the usually separate royal enclosure and tomb of the ancestor kings at Abydos, a symbol of Upper Egypt, with the royal, subterranean house-tomb of Lower Egypt, Djoser's RMC symbolises the unification of Upper and Lower Egypt (Kaiser 1969; Stadelmann 1995). It is also thought that the pyramidal shape that appears with his reign, in addition to reflecting a desire to make this component of the RMC more visible and thereby perhaps counteract the reduced visibility the tomb would otherwise have if placed inside the monumental enclosure, indicates that RMCs now take on a new solar and celestial character (Lauer 1962; Stadelmann 1996). By the 4th dynasty, developments in RMCs design are thought to be associated with the rise in prominence of the solar cult and change in concept of kingship, with the king elevated from a territorial ruler to a celestial, or cosmic, one (Kemp 1989: 62; O'Connor 1998: 140; Quirke 2001: 126). More speculatively, the pyramid has been described as a geometric version of the solar *ben-ben* stone at Heliopolis and a symbol of the king's ascent to the heavens (Kemp 1989: 103; Wilkinson 1999; Quirke 2001). The layout of OK RMCs is thought to be a rendering of the cosmos and cosmic processes of cosmogony, renewal and governance (O'Connor 1998).

Regardless of the details, there is a general consensus that RMCs were monumental displays of the king's ability to control resources, both natural and human (Trigger 1984, 1990; Edwards 1993) and it is likely that through them the king was able to legitimise his position at the apex of society, confirming the ruling class's political hegemony and a growing social inequality (Trigger 1984, 1990). Thus, one prevailing view is that RMCs did not only help order an increasingly unequal society via the symbolic meanings – the latter here understood as being systems of representation used to express otherwise complex, abstract and/or intangible notions – vested in their shape and layout, but also involved a political statement made via the conspicuous cost of their construction (Kemp 1989: 103; Trigger 1990). This view has been mostly argued for the later OK stone RMCs, whose size and use of stone made them particularly visible and enduring markers (Trigger 1984, 1990; Wilkinson 1999). It has also been argued that the layout of the pyramid's immediate environs, and in particular the introduction in the 4th dynasty of a royal cemetery around the king's tomb cemetery, reflect a changing relationship that the king had with the ruling elite (Roth 1991).

On a more mundane level, it has also been suggested that OK RMCs functioned as economic and administrative centres used for gathering taxes (especially the OK mortuary temple) and as redistribution centres in a ration-based society (Kemp 1989: 111-28). According to such an argument, RMC building projects became the main aim of the administration (Kemp 1989: 117-28; see also O'Connor 1974: 18; Stadelmann 1997) and this argument becomes even more plausible from the 5th dynasty on, a period for which we have numerous records (Posener-Kriéger and Cernival 1968; Posener-Kriéger 1976, 1983, 1985) and during which mortuary temples become increasingly large (Stadelmann 1997).

Location

Compared to studies focused on developments in the shape, layout, decorative program and immediate surrounding cemeteries of RMCs, studies explicitly concerned with understanding changes in site location and what they can tell us about the role of RMCs remain few. Those studies that do exist on this topic have focused on trying to understand the seemingly haphazard site-hopping that characterises the OK RMCs built in the Memphite region. The locational choices of the ED RMCs exhibit less interesting patterns than their later counterparts, as they form small, dense clusters within a single cemetery either at Abydos or Saqqara and the move of the royal necropolis from Abydos to Saqqara at the start of the 2nd dynasty and the temporary return to Abydos at the end of the 2nd has only been addressed in passing by commentators, the underlying reasons remaining unclear (Hoffman 1991: 328-32; Roth 1993: 48; Wilkinson 1999: 240). As there are no known documents that could help explain why a burial site was chosen, archaeologists have attempted to explain the patterns of site selection via rather circumstantial evidence. Various reasons have been proposed so far for the choices behind different RMC site locations, and for the purposes of the summary offered below, these can be grouped respectively into those that prioritise: (a) the changing location of Egypt's capital city and/or royal residence, (b) access to local resources and other logistical considerations (c) socio-symbolic concerns. While most agree that different considerations influenced site selection, practical factors which can be more readily recorded and measured have so far been favoured (Goedicke 1995, 2000; Bárta 2005; Jeffreys 2009: 257).

It has been argued that the cluster of RMCs in the Memphite region is evidence that proximity to the capital was a determining factor in site selection and that changes in the location of the capital (Erman 1984; Goedicke 1995, 2000; Malek 2000: 99; Bárta 2005; Jeffreys 2009: 263-4) and/or the royal residence (Love 2000) – although archaeologists have yet to locate a royal residence (Jeffreys 2009: 264) – explained changes in RMC location. Proximity to the capital gave access to a specialist workforce, workshops and storerooms required for building large monuments generally associated with capitals (Malek 1994). This has been used to explain the move from Abydos to Saqqara at the start of the 2nd dynasty and the southward move of the 5th and 6th dynasty RMCs as the capital moved, or expanded, southward from Wadi Abusir to Wadi Tafla, because of the Nile's eastward migration (Malek 2000; Jeffreys 2008), something Bunbury and Lutly (2008) argued more recently for Shepseskaf's choice to build at South Saqqara. Jeffreys (2009) study of intervisibility between RMC sites and the capital suggest that a conceptual link to the capital was important in site selection for the OK RMCs. Observing that the smaller pyramids cluster around the capital while the larger pyramids tend to be further from the capital, Jeffreys concluded that visibility from and to the capital was important and proximity to the capital determined the size of RMCs (Jeffreys 2009: 262-3).

Building on this is the idea of immediate material availability, whereby building in the Memphite region offered practical advantages by allowing easy access to on-site limestone quarries (Trigger *et al.* 1983; Malek 1994; Bárta 2005: 187-8). The quest for a better limestone has also been given as a reason for leaving certain sites such as Saqqara and Meydum and to explain the shifts visible within the Memphite region particularly for the later 4th dynasty RMCs, whose scale required quality limestone (Arnold 1991: 159; Malek 1994: 113). However, it has also been noted that since limestone quality becomes increasingly poor as one moves south from the capital, this argument cannot explain all site location choices, especially those made in the earlier part of the 4th dynasty with Snefru's three RMCs south of the capital (Love 2004: 21). Another key factor in site selection that has also been put forward, particularly for the large-scale stone RMCs of the OK, is the importance of the local geology and topography, which determined much of the structural constraints of a site have (Kemp 1983: 87, 1989: 132). Indeed, practical necessities relevant to almost any building project have so far been emphasised, such as being above the floodplain, choosing a flat unencumbered space, modifying an existing rock knoll for stronger foundations, having a supply of water either from the river or a major canal (Edwards 1993; Malek 1994: 113; Bárta 2000). Over-crowding and the management of waste from an unfinished monument has also been used to explain the move away from Saqqara in the 3rd dynasty and the systematic change thereafter (Murnane 1983: 148; Malek 1994: 111). However, site congestion does not apply to all RMC sites, such as at Abusir, where all 5th dynasty RMCs cluster and which would have been possible due to their reduced scale facilitating same-site building by generating less waste (Love 2004). Alone, these practical considerations shed light on the logistics of large-scale stone building, and on the role of such logistics in site selection. Trigger *et al.* 1983; Goedicke 1995, 2000; Lehner 1985a, 1985b, 1997, 2002, 2004; Bárta 2005; Jeffreys 2009: 257). Yet none of these practical considerations apply to all RMCs and they do little to explain site selection across building types, such as the mudbrick examples of the ED or how site location may have been manipulated to express notions of kingship.

Some commentators argue that RMC location is mostly the result of functional concerns, and that the desire to express more abstract, symbolic notions, often assumed to be religious, only influenced the layout of the RMC, not its landscape location (Bárta 2005). In contrast, others suggest proximity to one's ancestors as a reason for site selection, whereby family allegiance and feuds potentially explain cluster groups and departures from a site (Malek 2000: 99). Family allegiance has been proposed for the 1st dynasty kings buried at Abydos who are likely to have been direct descendants of the Late Predynastic chiefs buried there, and also the 2nd dynasty RMCs at Saqqara, the 4th dynasty at Giza and the 5th dynasty cluster at Abusir (O'Connor 2009: 147-55). Proximity to one's immediate or more distant 'ancestor king' has also been put forward as an important ideological incentive for site location (Malek 1994: 113; O'Connor 2009: 147-55).

Studies assessing site-lines and intervisibility between RMCs and various other monuments and locations in the landscape support the notion that religious concerns were important factors in site selection and that space and location were being manipulated. For instance, allegiance to the sun cult at Heliopolis is used to explain the location and orientation of the RMCs north of Saqqara (Jeffreys 1998, 2009: 157; Quirke 2001) in a way that suggests that site location may reflect negotiation between different political groups (Bárta 2005: 178; Jeffreys 2009: 264), but this has rarely been developed further. Love (2006a,b, 2007) suggests that proximity to earlier non-royal sites that were symbolically charged – such as Predynastic-ED cemeteries or the hot springs at Helwan – was also an important factor of OK RMC site location. Richards (1999) study of the ED RMCs at Abydos places the tombs in a deeply ritualised landscape and notes how proximity to the wadi, considered a gateway to the Land of the Dead, was of prime importance (also O'Connor 2009: 174-7).

In summary, the reasons for RMC site selection remain debated and while a combination of practical, social, political and symbolic reasons are often recognised as important aspects of site location, logistics nevertheless have taken precedence in existing commentaries.

Building Materials

While much attention has been paid to the design and layout of RMCs, and to a lesser degree to locational patterns, long-term developments in RMC material use have received much less attention, probably due to lack of contemporary textual evidence on this topic (Hoffmeier 1993; Spence 1999; Baines 2000; Karlhausen 2000). Material use has so far been mentioned largely in passing and in simple descriptive terms (i.e. Petrie 1883, 1893; Fakhry 1954; Lehner 2004), with frequent examples of material misidentification (Aston 1994; Aston *et al.* 2000). Existing comments have tended to focus on overall volumes consumed and what that might tell us about a king's power (Stadelmann 1980; Kemp 1990) or the workforce involved in the construction, the latter being an undeniably important theme returned to at the end of this section and in Chapter 3 (Petrie 1883; Reisner 1931; Lehner 2004; Bloxam *et al.* 2009).

Implicit or explicit in commentaries about material patterns in RMCs has been an assumption that mudbrick and limestone were preferred for RMC masonry building and consumed in such vast quantities mainly because there were ready sources near the construction site (Lucas 1962: 52; Aston 1994: 37; Aston *et al.* 1999: 40). From its earliest documented use, the ready availability of mudbrick made it the preferred material for domestic architecture, palaces and administrative buildings as well as elite funerary architecture, such as the ED royal tombs at Abydos (Spencer 1979a: 3; Kemp 2000). As mentioned earlier, limestone, which was widely available in the Memphite region from outcrops at the edge of cultivation area, became the preferred material for RMC masonry from the late 2nd dynasty onwards and eventually all non-domestic architecture (Spencer 1979a; Baines 2000: 29; Kemp 2000; La Loggia 2008) to the extent that material availability is believed by some to have been one of the prime reasons for the location of stone RMCs (Trigger *et al.* 1983; Malek 1994; Bárta 2005: 187-8).

Another existing opinion in current understandings of *changes* in material use is that mudbrick replaced perishables, such as reed matting or wood beams, because it was stronger and more permanent, and that the same applies to later perceived transitions, such as limestone replacing mudbrick and perishables and harder stones replacing softer[1] ones (Lucas 1962: 42; Aufrère 1991: 695-703; Kemp 2000; La Loggia 2008: 85). It is generally understood that stone offered greater longevity for the tomb and increased protection of the burial goods (Köhler 2005: 27; La Loggia 2008: 85). Such views also contributed to the idea that the harder the material, the more showily it could be used to demonstrate a ruler's power (Stadelmann 1980; Trigger 1990). Thus, increases in the overall volumes of stone consumed in the 4th dynasty RMCs have largely been viewed as a changing index of a ruler's power (Stadelmann 1980; Trigger 1990). Indeed, stone has commonly been discussed in connection to displays of power in Egypt (De Putter 2000a). This is also implicit in discussions of the use of larger quantities of hard stones in the 4th dynasty (Hoffmeier 1993; Mallory-Greenough *et al.* 2000; Bevan 2007: 41-4).

Only a small number of studies offer a more detailed and systematic analysis of some of the patterns of stone use, mostly hard stone, visible in OK RMCs. For example,

[1] Stone that ranks above 5 on the Mohs scale, which is an ordinal scale ranging from 1-10 that helps describe a mineral's hardness through its resistance to scratching by a harder mineral with 1-3 being described as soft and 3-5 as medium and serving as useful indicators of the degree of work required to process a stone; see Bevan 2007: 41-4 and Hoffmeier 1993; Mallory-Greenough *et al.* 2000.

Mallory-Greenough and colleagues (2000) demonstrate that the basalt used in the OK RMCs – and as early as the Predynastic for stone vessels – was sourced from a single quarry of the Haddadin formation in the Fayum and that the stone's physical properties played a major part in the material's use in an RMC. The stone's slightly developed columnar joining made the quarrying easier by enabling the workers to cut the stone in ways that followed predictable patterns and break it neatly along the joins into blocks under 2 m that were easy to transport. The type of basalt available closer to the OK RMCs was dismissed as it does not provide the mass required when available in boulder form or such ease of quarrying or homogeneity (Mallory-Greenough *et al.* 2000). In addition, the Fayum quarries were near water (c.10 km), and this transportability by water likely added to the material appeal (Lucas 1962: 60; Hoffmeier 1993; Harrell and Brown 1995). Bloxam and Storemyr (2002) offer additional insights into the organisation of work for the Fayum basalt quarries.

Existing commentary on material use in RMCs also put forward the notion that stone may have also symbolised permanence and eternal protection of the deceased but that colour choice was also important (De Putter 2000a). For example, Spence (1999) argued that the symbolic value associated with the three main colours of stone used in RMCs – red, white and black – determined their arrangement in RMCs to re-create a microcosm of the world (see also O'Connor 1998). This view suggests that white was often seen as a symbol of purity in Egyptian thought, and when used for upper wall portions, may have symbolised the heavens, which were considered pure and sacred (see also Aufrère 1991: 695-6). Both Spence (1999: 115) and Hoffmeier (1993: 121) inferred that basalt, which is only used for floors and lower portions of walls in RMCs, may have been associated with the black earth *kmt,* which was also the term the Egyptians used to designate the land of Egypt, and by extension may have acted as a symbol of renewal and fertility and have been associated with the earth gods Geb and Aker (see also Baines 2000; Karlhausen 2000). Therefore, the use of basalt may have been both practical and symbolic. Since a red band often separated the white celestial realm from the black earthly one in 5th and 6th dynasty RMCs, Spence (1999: 115-6) argues that red stones may symbolise liminality, rather than have acted as a symbol for the desert, danger and blood as is commonly suggested for red things (Brunner-Traut 1977: 124; Ritner 1993: 147). Such symbolic linkages are returned to with reference to a wider range of evidence in Chapter 9.

Turning to the possible symbolic implications of mudbrick use in RMCs, the only passing suggestion is Wood's (1987), that mudbrick could have been favoured in ED and a number of later tombs because it symbolised life and regeneration based on the provenance of its main constituent, silt (see also Aufrère 1991: 675; Goyon *et al.* 2004: 104-5). With reference to the transition from mudbrick to stone use in RMCs, Wood (1987) further sees the relatively early use of stone in tombs (e.g. limestone in the 1st dynasty private tombs at Helwan, granite in Den's tomb at Abydos), and possible early use in temples as proof that the Egyptians had the knowledge to use stone in architecture considerably earlier, but were conservative in making a wholesale switch for RMCs until later on.

In summary, RMC material selection remains an understudied topic, with most existing commentaries focusing on the practicalities of building with stone. While there have been a wider set of important insights, both on RMC sites and in wider quarry landscapes, these have not previously been brought together in a systematic manner. A few existing studies offer discussion on possible symbolic meaning attached to material use in RMCs, but these remain isolated from one another, and few if any address mudbrick in any detail. There is also a real need to devote more attention to the ways that RMC location and materials are interconnected.

2.3. The Workforce behind RMCs

There is considerable literature on the organisation of the construction work necessary for RMCs, and, since Herodotus, the focus has been on the stone workforces on-site, probably due to the sheer scale of OK stone RMCs, the latter which has also contributed to the idea that the workforce consisted of hundreds of thousands of coerced workers, a view encouraged by Herodotus' (*Histories* 2.125) claim that it took 100,000 slaves to built Khufu's pyramid. Subsequent estimates have ranged between 10,000 and 120,000 workers (Borchardt and Croon 1928; Mendelssohn 1976). Later it was thought that the majority of the workers consisted of employed conscripts who the ruling elite largely exploited during the inundation when they could not work in the fields (Petrie 1883: 209-15). Such views and estimates are often based on the total number of blocks thought to have been used for a pyramid and because the 4th dynasty pyramids alone required approximately 9 million m^3 of stone, with a total population estimated at about half a million for the OK, it is easy to see how such claims remained unchallenged and RMC building considered costly for the workforce (Stadelmann 1980). However, it was recently pointed out that most pyramids have blocks of various sizes, with copious amounts of sand and rubble, and some built around rock knolls, altogether reducing the overall construction task tremendously (Lehner 2002: 4-5). Apart from two later Exemption decrees of the 5th and 6th dynasty, dated to the reigns of kings Neferirkare and Pepy II, that show compulsory labour for building projects existed in the form of a tax from which certain individuals could be exempt (Goedicke 1967), the evidence that workers were forced to provide work in the form of corvée is meagre, indirect and of a later date. Yet, such views persisted for a long time and have contributed to a 'monolithic' vision of a very large, coerced, passive and unskilled workforce (Bloxam 2008; Bloxam *et al.* 2009).

Fortunately, discoveries from Giza and remote quarries (Lehner 1997, 2001, 2004; Bloxam 2000; Bloxam and Storemyr 2002; Bloxam *et al.* 2008, 2009) have provided additional insights into stone-building logistics both on- and off-site. The workmen's settlement and cemetery at Giza represents the most valuable source of information regarding the workforce employed in the building of RMCs (Lehner 2001, 2004) and points to a much smaller workforce of 10,000-30,000, comprising builders and auxiliary staff. A pyramid the size of Khufu's would thus have required perhaps 4,000 builders, though 2,000 may have been enough for smaller RMCs (Dobrev 2003: 31; Lehner 2004: 12-3). The workforce was probably composed of both skilled and unskilled workers who provided both full- and part-time work (Lehner 2004). Full-time skilled specialists probably carried out quarrying and building (Petrie 1983). To these one may add a crew of artisans for building ramps and embankments, carpenters to make tools and sledges, metal workers to produce and sharpen tools, potters to produce the vessels used for the transportation of water used for mortar and to lubricate slipways, water carriers, bakers and brewers, to supply the workforce. Each trade also had an overseer who managed the work on site; in the case of Menkaure's staff at Giza, there is a reference to the 'master of masons' and the two 'grand commanders of the craftsmen' (Pfirsch 1993: 293; Dobrev 2003: 30; Lehner 2004). From the 4th dynasty onwards, the director of the king's works, often a vizier, was in charge of organising, managing and overseeing the royal building project (Pfirsch 1993: 293). Evidence suggests that the workforce was remunerated and the builders on site were a highly organised group in charge of both extraction and transportation of the limestone blocks used for the pyramids (Reisner 1931: 273; Lehner 2004). Control notes from Middle Kingdom RMC sites (Reisner Papyri) reveal that the workers followed a ten-hour day. Although later sources must be used with caution, this could well have been the case in the OK (Simpson 1963; Lehner 2004). Eyre (1987: 15-8) argues against the idea of seasonal work carried out in the inundation season, based on the fact that summers were too hot and on the statement by classical author Diodorus that work ceased and people feasted during the inundation. However, Classical sources on Egypt must be used with considerable caution, and in contrast to them for instance, modern quarrymen in many hot climates work throughout summer, adapting their working-hours to the cooler times of day. Although evidence shows that a full-time workforce was employed on-site, the possibility that additional help may have come in the form of a temporary workforce should not be entirely excluded as discussed shortly in the section on phyles. A temporary workforce represented an additional cost to building, and it remains unclear whether or not temporary labourers worked only in summer.

Commentators have noted that mason's marks painted on limestone blocks and a small number of tool inscriptions from RMC sites provide evidence that phyles (a later Greek word for tribe used to refer to the groups of part-time, unskilled workers known as *za* that constituted building crews) were called upon for the construction of RMCs from the 4th dynasty onward (Petrie *et al.* 1910: 9; Eyre 1987: 11-8; Roth 1991: 61-74; Dobrev 2003; Lehner 2004). Roth (1991) has provided by far the most important discussion on phyles. Four main phyles, known as *wr*, *stj*, *wadjet* and *ndjs*, existed in the ED and OK (Roth 1991: 9-36). It is unclear whether the order commonly found in inscriptional evidence, *wr*, *stj*, *wadjet* and *ndjs* is hierarchical. However, what is certain is that with the *wr* phyle, *wr*, which means 'great', always comes first in lists and is exclusive to royal contexts, being the most prestigious. Altogether the evidence points to a tight bond with the royal institution and the state (Roth 1991: 37-9). The earliest attestations are phyle names inscribed on a jar and a few seals dated to the 1st dynasty. In the ED, phyles worked for the royal palace and mortuary cult, fortified enclosures, and a number of other cult of divinities, showing continuity with, but also more diversity than, the later OK phyles (Roth 1991: 87-8).

From the 4th dynasty onwards, phyles are mainly connected with the building of RMCs, namely the quarrying, transportation, positioning of the masonry and finishing work, as tool inscriptions and mason's marks painted on blocks of stone indicate (Roth 1991:

124). We know that by the 4th dynasty, one crew of builders was formed of two gangs, each composed of four phyles themselves formed of four divisions of ten men each overseen by a full-time 'overseer of ten' (Roth 1991: 120; Lehner 2004: 12-3). This means that the large building projects that required about 4,000 men, were most likely organised into two crews of 2,000, each composed of two gangs of 1,000, each formed of four phyles composed of 250 men organised as 25 division of 10 men (Lehner 2004: 12-3). Lehner (2004: 12) plausibly suggests that smaller RMCs would require 2,000 builders, six or seven crews of 320, each crew formed by two gangs of 160 men formed of four phyles composed of four divisions of 10 men each. We know that each gang had a name, which was often based on that of the king, such as 'The Friends of Khufu Gang' or 'The Drunkards of Menkaure' (Eyre 1987: 12; Roth 1991: 127), which Dobrev (2003) reads as 'The Labourers of Menkaure' (see Dobrev 2003 for a counter argument regarding division and phyles).

The pattern of occurrence of mason's marks in some 4th dynasty RMCs has also been used to infer the spatial organisation of the workforce on site. In Khufu's relieving chamber and Menkaure's mortuary temple at Giza one gang is repeatedly mentioned on the north side and another on the south side, indicating a north-south division of labour, where one crew formed of two gangs competed and cooperated on a specific area; the same phyle names were found in both gangs (Roth 1991: 119-24; Lehner 2004: 11, 2009: 9). Levelling lines on blocks were drawn *over* masons' marks indicating that marks were written on the blocks *before* their placement in the structure and that each gang was therefore in charge of a block from the quarry to its placement in the monument (Reisner 1931: 273; Roth 1991: 119-42). Several blocks in Menkaure's temple show the same continuing geological features across all blocks; therefore it appears that the blocks were placed side by side in the temple, just as they were cut in the quarry. It is generally accepted that the builders of RMCs were organised in the same way as the 5th dynasty priestly phyles, who followed a system of rotation, working in a temple for one month and then moving on to another temple over a period of ten months, albeit with a slightly different organisation given the larger numbers (Posener-Krieger 1968; Roth 1991: 6; Dobrev 2003: 30; Lehner 2004: 12). Possible barracks (35-55 m long) at Giza could have housed a group of temporary workers lying side-by-side in two rows (Lehner 2002: 69, 2004: 13). While most agree that from the 4th dynasty, at least, the groups of on-site builders were organised following a long-established social system comparable to the phyle system (Eyre 1987; Roth 1991: 61-74; Lehner 2004), this has hardly ever been expanded upon in terms of the role RMC building may have played. The role of phyles in RMC building is generally understood as a practical solution to a practical problem (Roth 1991: 207).

Although not focused solely on RMCs and their role in society, recent studies have shown that the extraction and acquisition of OK hard stone from distant and remote quarries, in particular basalt (and gneiss for statuary), took place in the form of seasonal expeditions led by small and highly specialised groups of stone experts (Bloxam and Storemyr 2002; Bloxam *et al.* 2009). The temporary nature of settlement and the geographical spread of hard stone tools across these remote quarry sites suggest that the expeditionary groups worked on a seasonal basis, moving from quarry to quarry (Bloxam *et al.* 2009). Because every stage except hauling required skilled workers, specialists were based at the quarries, especially for the hard stones (Arnold 1991: 20-1; Bloxam 2000; Bloxam *et al.* 2009). Evidence for granite processing workshops at Abu Rawash and for basalt sawing at Giza suggests that hard stone specialists were also present at the building site (Moores 1991; Klemm and Klemm 2010: 103). Although the evidence is unclear, the nautical terminology used to organise the workforce may indicate that the workmen were also in charge of transportation, which was largely riverine (Roth 1991: 46-52). Late OK inscriptions from the Hatnub and Wadi Hammamat quarries indicate that the majority of work in these quarries was done during the cooler months of *peret* and *shemu,* between autumn and spring (Eyre 1987: 16-7; Eyre 1994), but that this material was probably then stored and transported during the hotter summer months of the inundation (Harrell and Brown 1995; Bloxam *et al.* 2009; Kelany *et al.* 2009).

A final point to stress is that the mudbrick workforce called upon for ED and OK RMCs has received far less attention than the one involved in the OK stone monuments. The main reference offered by existing commentaries with regard to mudbrick manufacture comes from the NK tomb of the vizier Rekhmire at Thebes (Davies 1943: 54-5). Although the scenes are idealised, because they concur with modern day parallels they are generally accepted as accurate depictions of the basic sequence of events (Davies 1943: 54-5; Spencer 1979a: 3). They show water carriers pouring water into pools to make the paste, the treading of the paste, transportation to the brick yard where the paste was formed into bricks with wooden moulds, the laying of the bricks to cure, and carriers taking the dry bricks to the building site. The artist changed the colour of the bricks from pink-grey to pink and white to show the transformation of the materials as they were cured (Davies 1943: 54-5; Spencer 1979a: 3; Kemp 2000: 83). However, the number of workers depicted and the spatial organisation of work may have been determined by the artistic space available on the wall rather than reflecting reality. Also, the number of bricks carried may have been more than the four depicted (Emery and Morgenstein 2007: 115). Hence the pictorial evidence probably gives a sense of manufacturing stages, but not of the size, organisation and composition of the workforce.

Beyond this, there are two studies only that provide more substantial discussion of the organisation of the workforce for mudbrick RMC construction: Engel's (2008) which deals with the ED RMCs at Abydos and Arnold's (1991) which deals with the MK RMCs at Lahun and is essentially based on control notes. Of interest for this study is Engel's. Because there is general consensus that mudbrick manufacture and building techniques appear to have changed little since antiquity (Spencer 1979a: 3; Kemp 2000), Engel (2008) combined ethnographic information with empirical data collected during the re-excavation of Qaa's tomb at Abydos to calculate estimates regarding the workforce and the organisation of work on site. For analogous large-scale construction, she refers to the Gurna project near Luxor which the Egyptian government commissioned in the 1940s (Fathy 1969). Engel (2008: 33) calculates that it would take a team of 10 workmen and 30 porters 100 days to excavate the pit. The space in the tomb allowed for three crews of one bricklayer and a maximum of three assistants to prepare and transport the bricks. Three crews would have completed the first building phase in 300 days and a single bricklayer would have finished the second in 120 days. Taking into account holidays and delays, it would have taken about two years to complete Qaa's tomb (Engel 2008: 33). The volumes of materials required and the way in which the workers were organised and distributed across the site is similar to that visible in the Kahun and Reisner I Papyri, suggesting some degree of continuity in practice for the large-scale projects (Emery and Morgenstein 2007: 118). Engel's and Arnold's studies are the only ones that have attempted to shed light on the organisation of the mudbrick workforce employed for RMCs, one kind of organisation for the MK monumental pyramids, the other for the much smaller ED royal tombs at Abydos.

2.4. Chronology and Tomb Ascription

A final key preliminary to address prior to the discussion offered in later chapters is the chronology of individual RMCs and the success with which each has been attributed to the work of a specific ruler. No contemporary 'king lists' exist for the period under study as they do for later periods and hence historians have tended to turn to later king lists for early chronology. Available to us are the Palermo Stone from the end of the 5th dynasty, the Wadi Hammamat Inscription from the Middle Kingdom, the Abydos, Saqqara and the Turin king lists from the New Kingdom and Manetho's king list from the Late Period (Drioton 1954; Lauer 1963; Wilkinson 2000). These lists are not only of much later date, but also often incomplete or erroneous. They can repeat themselves, lengthen or shorten reigns, and do not always match the contemporary archaeological record. The task is also made harder by the fact that kings had several names so that it is not always clear if we are dealing with different kings or just one king (Lauer 1963; Dodson 1996, 1998; Seidlmayer 2006). Hence, it is best to prioritise the available contemporary evidence, which consists of seals, inscribed vases, quarry and builders' marks and tomb inscriptions, over later chronologies. Altogether, the available evidence makes it possible to reconstruct a useful relative chronology of kings and monuments for the period under study. The following section reviews the evidence first for chronology and then for monument ascription. Before proceeding further, it is also important to note that it is through Late Period king lists that the practice of breaking down royal succession into dynasties appeared. Such dynastic divides that regroup a number of kings together did not exists as such prior to the Late Period, but are commonly followed in the study of the history of Pharaonic Egypt and hence followed here for ease of discussion.

The 2nd Dynasty

There are no king lists to help us determine the chronology or sequence of kings for the 2nd dynasty. Most of the evidence comes from the kings' names found inscribed on stone vessels used for rituals or festivals, administrative seals and labels. Later OK sources can also help; however, as all such sources are prone to scribal errors and shaped by ideology to some extent, especially the royal annals, it is important to use them with caution (Kahl 2006: 94). The following sequence of kings is generally accepted: Hotepsekhemwy, Raneb, Ninetjer, Weneg, Sened, Peribsen and Khasekhemwy. While the tombs of Hotepsekhemwy and Ninetjer are both attested at

Saqqara, a funerary cult associated with 2nd dynasty king Sened, whose RMC was at Saqqara, is also attested inscriptionally (Mariette 1885; Khal 2006: 105). A ruler known as Horus Sekhemkhib is also attested in the contemporary evidence and there is debate as to whether Horus Sekhemkhib and Seth Peribsen are same king or if they are two separate kings and that Sekhemkhib buried Peribsen (Kahl 2006: 105). It is generally understood that some sort of political instability arose in the mid-2nd dynasty, and while Peribsen claimed rule over the whole of Egypt, he is only attested in the contemporary archaeological record in Upper Egypt, from Elephantine/Aswan to Beit Khallaf, just north of Abydos (Mariette 1885; Khal 2006: 105). Khasekhemwy, whose monuments are the first to be considered in this study, was thought in later tradition to be Peribsen's successor and the last ruler of the 2nd dynasty. However, direct succession between these two kings remains uncertain (Mariette 1885; Khal 2006: 105). There is no evidence of a 'Sekhemkhib' being buried anywhere in Egypt; both Peribsen and Khasekhemwy returned to Abydos to build their tombs; and Khasekhemwy's initial tomb design is almost identical to Peribsen's. Therefore the available evidence neither rules out nor unequivocally supports a Peribsen-Khasekhemwy succession.

The 3rd Dynasty

The chronology of the earlier part of the 3rd dynasty is better established than that of the latter part for which the exact number and names of rulers remains unclear (Lauer 1963). Based on current evidence, it is estimated to have lasted a minimum of 50 years and a maximum of 75 (Seidlmayer 2006: 123). Manetho's king list does not give much information because reign lengths tend to be inflated and the list also has many repetitions. The NK king lists are more useful, with the Westcar Papyrus giving the name and sequence of two 3rd dynasty kings (Seidlmayer 2006: 116). Seidlmayer (2006: 116) and we can correlate the information from these lists with the names on monuments, especially the RMCs to help establish the number and sequence of kings. The main problem with the OK sources is that kings are identified with their Horus name, as they had been previously, but for the first time, two kings also have their personal names written in a cartouche. These are kings Nebka and Huni so that for the 3rd dynasty we are faced with the problem of correlating the Horus names of the lists and with the personal names on the monuments.

Five rulers are known from contemporary inscriptions; Netjerikhet (Djoser), Sekhemkhet, Khaba, Zanakhte and Qahedjet. Swelim (1983: 181-3) added two rulers, but Seidlmayer (2006: 118) plausibly explains why these cannot actually be considered as kings. Only Netjerikhet and Sekhemkhet's names have been found in an RMC. The Abydos king list and the Turin Canon give Nebka as Djoser's predecessor and founder of the 3rd dynasty, who was often associated with the Zanakhte of contemporary sources (Lauer 1963). However, all contemporary and later OK evidence indicates that Nebka reigned toward the end of 3rd dynasty, and clay seals Dreyer and his team excavated from inside Khasekhemwy's tomb at Abydos confirm that Djoser oversaw Khasekhemwy's burial, thus establishing a direct link between the two rulers (Dreyer *et al.* 1996, 1998; Seidlmayer 2006: 118-20). The name Djoser was never found on any contemporary structures, but rather is known as Netjerikhet in contemporary inscriptions at Saqqara, Beit Khallaf, Abydos, Hierakonpolis, Elephantine and other parts of Egypt including the Sinai (Swelim 1992: 547). However, Djoser is preferred in the dissertation, as it is the most common way this king is referred to.

Sekhemkhet is generally accepted as Djoser's successor mostly because their names and RMCs are so similar. Also, the fact that Djoser's architect's name 'Imhotep' was found inscribed on ~~a~~ blocks from Sekhemkhet's enclosure strongly supports the idea that Sekhemkhet was Djoser's immediate successor (Goneim 1956, 1957).

Khaba is known from seals from Zawyet el-Aryan and Dahshur, clay tablets from Hierakonpolis and an inscribed vase, probably reused, from the later 5th dynasty royal cemetery at Abusir (Dodson 1998: 35). The fact that Khaba's name was found inscribed on vases from mastaba Z500 at Zawyet el-Aryan and that the RMC is so similar to the step pyramids at Saqqara means that he is generally considered the owner of the structure, leading to his placement after Sekhemkhet in the chronology of the 3rd dynasty. However, because the name was not actually recovered from the pyramid itself, Seidlmayer (2006: 120) argues that Khaba could also be a successor of the king buried in the Layer Pyramid at Zawyet el-Aryan.

Nebka is associated with Zanakhte because the two names seem to appear together on a seal impression from mastaba M2 at Beit Khallaf. On it, the name Zanakhte is accompanied by a name that finishes with *–ka*, possible Zanakhte, inscribed in a cartouche (Garstang 1898; Seidlmayer 2006: 120). Other seals bore Zanakhte's name only. The fact that the seals were found at Beit Khallaf, where Netjerikhet (Djoser) is attested, initially led some to place Zanakhte/Nebka early in the 3rd dynasty, as the later king lists suggest (Lauer 1963; Dodson 1998: 33). Zanakhte is also attested at Wadi Maghara, Elephantine and in Djoser RMC. A seal form Elephantine came from refuse of a Minor Step Pyramid (MSP hereafter), indicating a link between Zanakht/Nebka and the MSPs, though the stratigraphy is too poor to be any clearer regarding the relationship. This association with the MSPs, places the king towards the end of the 3rd dynasty, possibly after Khaba (Seidlmayer 1982: 304-5, 1996a, 2006: 121).

The NK lists give Huni as the last king of the 3rd dynasty and immediate predecessor of Snefru (Lauer 1963). Huni is the first king identified in contemporary sources with his personal name. No Horus name was found for Huni. However, although this cannot be absolutely proven at this stage, a relief slab depicting a king named Horus Qahedjet from Dahshur could be proof that Qahedjet was Huni's Horus name (Seidlmayer 2006: 121). Table 2.1 gives a list of 3rd dynasty kings and their possible RMC.

Name in Cartouche	*Horus name*	*RMC*
Djoser	Netjerikhet	Step Pyramid Complex
Djoserty	Sekhemkhet	Buried Pyramid
(unknown)	Khaba	Layer Pyramid
Nebka	Sanakht	Unknown
Huni	Qahedjet	Unknown RMC at Dahshur

Table 2.1. List of 3rd dynasty kings and possible RMC (from Seidlmayer 2006: 122)

The 4th Dynasty

The chronology for the 4th dynasty is relatively well established (Černý 1958: 28; Lauer 1963). Because of the above-mentioned limitations of later king lists, Lauer offers a detailed analysis of the seven known RMCs of the 4th dynasty, to help clarify some of the chronological issues. Lauer (1963) gives seven reigns for the 4th dynasty though he does not exclude the possibility of an eighth. The order of the first four reigns is the same in all NK lists: Snefru, Khufu, Djedefre and Khafre and is well attested in the sequence of monuments (Lauer 1963: 302). Since it is generally agreed that an 18-year reign, as suggested by the Turin Canon, can only apply to Menkaure, Lauer places him 6th in sequence and places an unknown ruler, possibly Nebka/Neferka, who is generally considered the owner of the Unfinished Pyramid at Zawyet el-Aryan (discussed later in this section) between Menkaure and Khafre (Lauer 1963: 24-3; Lehner 1997: 139).

Nebka/Neferka may have had such a short reign that later compilers of later king lists omitted him (Edwards 1994).

The MK Papyrus Prisse and the Saqqara king list supports the fact that King Huni was Sneferu's predecessor (Jéquier 1911). The 12th dynasty Wadi Hammamat graffito (Drioton 1954) lists Khufu, Djedefre and Khafre, Hordjedef and Bafre. All were most likely sons of Khufu, with the first two succeeding him in this order. The fact that their names were all written in cartouche, as if they had all been kings, could simply be an error (Drioton 1954; Lauer 1963: 308). Hordjedef does not appear on the Turin Canon or Manetho's king list, but since he was a highly respected individual by the 6th dynasty, his reputation is what could have led to his being inscribed on this list in a cartouche.

Hence we have seven monuments for seven kings for the 4th dynasty, as shown in the left column of table 2.2 below (Lauer 1963). The main problem is determining reign lengths, as it is unclear if the census years are biannual or not. There is also evidence that they were irregular until later in the OK (Verner 2006: 124). If the count is irregular, the minimum reign length is the highest year attested in the contemporary record. Possible reign lengths are given below.

King	*Maximum Year from Contemporary Record*	*Years from Turin Canon*	*Years from Beckerath 1997*	*Other*
Snefru	27 +	24	35	48
Khufu	13 +	23	23	
Djedefre (Radjedef)	11 +	8	9	23 (Vallogia 1997: 22-3
Khafra (Rakhaf)	15 +	?	26	
Unknown/ Nebka/Neferka	?	?	7	
Menkaure	14 (?) +	18	28	
Shepseskaf	2 +	4	5	

Table 2.2. Minimum regnal years for 4th dynasty kings (based on Verner 2006: 127).

Monument Ascription

It is crucial for arguments concerning chronological change in monument building and material use to review the evidence for the royal ownership of the monuments discussed in this research. While most investigations of the RMCs known for the period under study have yielded the names of their royal owners, a few have not. These include the Layer Pyramid and the Unfinished Pyramid, or Great Pit, at Zawyet el-Aryan, the Mudbrick Pyramid at Abu Rawash, otherwise known as Lepsius 1, the first construction phase of the Meydum pyramid at Meydum and Mastaba Faraun at South Saqqara. Detailed consideration of the architectural and inscriptional evidence has led archaeologists and historians to propose different possible chronological placement for these monuments as well as possible owners. Although tentative, some of these arguments are more convincing than others. This section reviews the evidence for the ascription of the RMCs to a specific ruler with an emphasis on those for which the ascription is contested.

Khasekhemwy's Monuments

Petrie discovered Khasekhemwy's tomb at Abydos and assigned it to him based on the multitude of seals and other objects inscribed with the ruler's name found inside the tomb (Petrie 1901; Dreyer *et al.* 1996, 1998: 31-4). Ayton also dated and assigned the Shunet el-Sebib at Abydos to Khasekhemwy in 1903 based on seals with the king's name found in the enclosure chapel (Petrie *et al.* 1904: 3). Pottery evidence from another enclosure named the Fort at Hierakonpolis helped identify Khasekhemwy as the owner of at least the second building phase of this enclosure (Quibell and Green 1902; Friedman 1999, 2005, 2009). The limited height of the first phase walls and the lack of coating, which indicates that the first phase was never completed, and the second phase's respect of the initial plan suggests that only a short time span elapsed between the two building phases making it likely that the same owner, i.e. Khasekhemwy, was responsible for both phases (Friedman 2005, 2009). This is the view taken in later chapters. Pottery evidence from a third enclosure built with limestone, known as the Gisr el-Mudir, at Saqqara has been tentatively dated to the late 2nd dynasty and early third dynasty (Mathieson *et al.* 1997). Although the pottery is typical of the late 2nd and early 3rd dynasty, the quality of execution visible with Khasekhemwy's successor Djoser's RMC built just a few 100 meters east of the Gisr el-Mudir would suggest the Gisr el-Mudir is earlier. Khasekhemwy's use of limestone masonry for his tomb at Abydos clearly links this ruler to the use of the material in royal mortuary architecture, and his monumental building activities that clearly demarcate themselves from any predecessor, also associate him with monumental building projects. The late 5th dynasty royal records known as the Palermo Stone also records either for Khasekhemwy's reign the construction of a building in stone called Men-netjeret, 'the goddess endures'

(Wilkinson 2000: 132). Although Khasekhemwy's ownership cannot be proven, the evidence strongly supports the likelihood of his ownership of the Gisr el-Mudir.

Djoser's RMC

The Step Pyramid Complex at Saqqara was ascribed to Djoser thanks to both builder and seal inscriptions (Lauer 1936). These identify the owner of the tomb as Horus Netjerikhet who was only later identified as Djoser, as NK graffiti from the complex indicate. King Djoser is only known from contemporary sources as Horus Netjerikhet; Djoser was never actually found on any contemporary structures where this king is attested, such as Saqqara, Beit Khallaf, Hierakonpolis, Elephantine and the Sinai (Swelim 1992: 547). However, it may be that not all of Djoser's RMC belonged to him alone. Evidence suggests that not only did Djoser reuse many of the stone vessels found in his tomb, but that he also reused earlier structures (Lauer 1963; Stadelmann 1985; Tavares 1995: 1137; Regulski 2009). The tunnels under the step pyramid, most of which contained the above-mentioned stone vessels, are cut differently and follow a different plan to the rest of the substructure and as such appear to be of an earlier date (Lauer 1936; Stadelmann 1985). Seal impressions with Khasekhemwy's name were recovered from the northern galleries under the pyramid (Stadelmann 1985; Regulski 2009: 228). Stadelmann suggests that the western gallery magazines, later included in Djoser's complex, were part of a Saqqara tomb of Khasekhemwy's (Stadelmann 1985: 298-9, 1996: 795). This would in principle then mean that Khasekhemwy had two tombs, one at Abydos and one at Saqqara. Proof might exist in a 4th dynasty title of a priest who was 'overseer of the funerary priests of Peribsen in the necropolis of Sened' (Mariette 1885: 92-4). With Sened being a 2nd dynasty king buried at Saqqara, the inscription suggests that Peribsen also had a funerary complex at Saqqara. Stadelmann also believes that two lion-shaped offering tables that Mariette discovered in a shaft north of Djoser's complex indicates the presence of a 2nd dynasty temple that was later incorporated in the northern part of Djoser's RMC (Mariette 1885: 83-6; Stadelmann 1985: 298-9). Although the late 2nd dynasty presence, and especially Khasekhemwy's, on the Saqqara plateau is evident (Stadelmann 1985; Tavares 1995; Mathieson *et al.* 1997, 1999; Mathieson 2000; Van Wetering 2004; Regulski 2009), the galleries were never properly excavated and solid evidence for ascribing them to Khasekhemwy is lacking (Kaiser 1994).

The Buried Pyramid

The RMC commonly referred to as the Buried Pyramid has been assigned to Sekhemkhet based on the jar sealings Goneim found inside the tomb with the king's name (Goneim 1956, 1957; Lauer 1963: 291).

Snefru's Bent Pyramid

Officials from Snefru's court were buried in the neighbouring cemetery (De Morgan 1895, 1903). An inscription found inside the tomb of a priest of the 5th dynasty buried at Dahshur states that he was 'Director of Snefru's Two Pyramids' and his son, who was buried with him, was 'director of Snefru's South Pyramid', which is the same title found inside the mortuary temple of the Bent pyramid, and that belonged to a MK priest. The inscriptional evidence, although of a later date, suggests that the expression 'director of Snefru's South pyramid' was a term used locally to refer to the Bent pyramid, the southernmost at Dahshur, indicating that the Bent pyramid was considered Snefru's by the 5th dynasty and still in the MK (Fakhry 1961: 15-6; Parra Ortiz 1996). Borchardt (1905: 1-2) excavated a stela in the valley east of the North Pyramid with a royal decree from late 6th dynasty dated to the reign of Pepi I that exempts the 'City of the Two Pyramids of Snefru' from paying tribute, indicating that both pyramids were considered to belong to Snefru (see also Weill 1912: 43-52). Hussein, while excavating the Bent pyramid between 1946-1949, found the name of Snefru inscribed on blocks inside the pyramid and at its corners, finally confirming what earlier inscriptions had strongly suggested. Unfortunately, Hussein's premature death in 1949 meant his notes were left unpublished except for a brief announcement (March 22nd 1947; Varille 1947; Fakhry 1961: 13).

Snefru North Pyramid

Snefru's Horus name Nebmaat, was found painted in red ochre on one of the casing blocks from the northeast corner of the pyramid (the term casing refers to revetment and is preferred here as is most common in Egyptological literature; Smith 1952: 113-28). The possibility that the block was reused was ruled out when a larger-than-life-size relief depicting Snefru wearing his *Heb-sed* gown was excavated from the mortuary temple (Stadelmann 1983: 232-4). Snefru's name was also found painted on some of the blocks of the southern satellite pyramid (Fakhry 1961). In addition to the royal decree Borchardt (1905: 1-11) excavated, a number of Snefru's officials were buried in the pyramid cemetery (Porter and Moss 1979).

Khufu

Phyle names based on Khufu's name Khnum-Khufu were found painted on the walls of the relieving chamber above the Great Pyramid's burial chamber (Vyse and Perring 1940: 279-84). Also, the individuals buried in the cemetery east of the Great Pyramid are all part of Khufu's family and those in the western cemetery were high officials of his court (Reisner 1942; Porter and Moss 1974).

Djedefre

Chassinat (1901) was able to identify the owner of the RMC at Abu Rawash when, in the mortuary temple, he found fragments of statues of the king with the name of Djedefre.

Khafre

Petrie assigned the second pyramid and its complex at Giza to Khafre based on a statue of the king that was inscribed with the name Khafre which Petrie excavated from the valley temple (Petrie 1883: 47-50).

Menkaure

For a long time, the identity of the owner of the third pyramid at Giza was only a matter of tradition (Herodotus, *Histories* II, 134; Reisner 1931: 4). Although Diodorus Siculus (I, 3) recorded that Menkaure's name was inscribed in the pyramid entrance, no such inscription was ever found. In 1937 Vyse and Perring (1940, Vol. II: 93) found a sarcophagus inscribed with Menkaure's name in the pyramid's burial chamber. However it was later shown to be a 26th dynasty a restoration, only indicating that the third and smallest pyramid at Giza was considered to be Menkaure's by that time. Vyse and Perring (1940, Vol. II: 48) also found Menkaure's name painted in red ochre on the ceiling of the middle of the three queens' pyramids (IIIb). Reisner who later carried out excavations early in the 19th century discovered inscriptions from stelae and statues found in the mortuary and valley temples and from neighbouring tombs that give Menkaure's name, as well as a number of workmen's inscriptions painted on blocks from the mortuary temple giving phyle names based on the name of the ruler Menkaure (Reisner 1931: 5). Today, there remain no major doubts that this monument belonged to Menkaure.

Now that we have reviewed the monuments that provide fairly clear evidence for ascribing them to specific rulers, it is worth turning to the existing evidence for five monuments where the ascription is more contentious.

The Layer Pyramid at Zawyet el-Aryan

The Layer Pyramid itself yielded no royal names (Barsanti 1901, 1906, 1912; Maspero 1906; Reisner and Fischer 1911). However, the neighbouring mastaba Z500 located 250 m to the north of the pyramid contained numerous vases inscribed with the name of Horus Khaba in a *serekh* (Dunham 1978; Lehner 1996). It is unclear if the Layer Pyramid and mastaba Z500 are exactly contemporary, yet both the mastaba and wider cemetery date to the 3rd dynasty (Dunham 1978; Lehner 1996). Swelim (1983: 198-205) challenges the ascription of this RMC to Khaba, on the basis that stylistically, the vessels appear earlier than those associated with Sekhemkhet, a presumed predecessor of Khaba. However, the sample size is too small to be conclusive (Dodson 2000: 87), and reuse of earlier uninscribed vessels should be considered since the practice is widely attested, as with the stone vessels found under Djoser's pyramid for instance (Regulski 2009).

Also, the similarities between the Layer Pyramid and Sekhemkhet's pyramid at Saqqara structures are so striking, such as the use of accretion layer for the construction of the pyramid and the layout of the substructures that are almost identical, the implication is that the two structures were built close in time (Lehner 1996; Dodson 1998). However, their designs differ in interesting ways. The topography of the Layer Pyramid suggests that, had the RMC been completed, the large rectangular enclosure as seen with Djoser and Sekhemkhet's complexes would have been abandoned in favour of a square enclosure wall, one similar to later OK RMCs and much reduced in scale (Lehner 1996). The evidence places the Layer Pyramid in the beginning to middle of the 3rd dynasty rather than the end, when RMCs start to resemble those of the 4th dynasty, especially the substructures (Lauer 1963; Seidelmayer 2006). As such, although we do not know for sure which monument ought to be considered in the sequence after Sekhemkhet's, most consider the Layer Pyramid at Zawyet el-Aryan as the most likely candidate. Khaba's name is clearly attested in the contemporary evidence as it is at the site, and as such was probably its owner (Lauer 1963; Lehner 1996; Dodson 1998).

The Mudbrick Structure at Abu Rawash

A mudbrick structure built around a rock-knoll located south of the modern village of Abu Rawash has been tentatively dated to the end of the 3rd dynasty and proposed as a potential tomb for 3rd dynasty rulers Zanakhte or Huni. The structure was never excavated and is very poorly preserved, limiting our knowledge to a single preliminary study Swelim carried out in 1987 and early explorers' short, often unsystematic and erroneous descriptions (Vyse and Perring 1840: 193-4; Lepsius 1849; Bisson de la Roque 1924: 3). No royal name was recovered from the site and dating is generally based on pottery and design (Swelim 1987a). Very little remains of the structure today, except for a simple T-shape substructure cut in the rock-knoll. The scant traces of mudbrick masonry laid around the knoll that were still visible early in the century have since disappeared (Swelim 1987a). Although the exact date and ownership of this structure remain unconfirmed, the pottery evidence points to a 3rd dynasty date. Yet, the shape of the internal apartment is only known for royal tombs of the 4th dynasty, and the entrance's elevation, the use of a rock-knoll and the structure's large dimensions, also seen with the 4th dynasty pyramids at Giza and Abu Rawash, seem to place the monument closer to the 4th dynasty (Swelim 1987a), as does the tomb's location north of the capital. Although dating and ascription are tentative, the 3rd dynasty pottery, the 4th dynasty design and the fact that the 4th dynasty chronology and sequence of monuments is relatively well established suggests that the structure likely belonged to a late 3rd dynasty ruler, which is where it fits best in terms of pyramid development (Dodson 1998: 35) It could be one of the missing RMCs of this period, potentially belonging to Kings Zanakhte/Nebka or Huni, who are both attested in the contemporary inscriptional evidence of the period, but for whom no RMCs have been identified (Swelim 1987a: 80-7; Dodson 1998). It should be said that the poor state of preservation and limited knowledge we have of the structure has led many to ignore it or confuse it with another mudbrick structure known as Ed-Deir north of the village of Abu Rawash (see Chapter 8; Macrammallah 1932; Swelim 1987a: 80-7). Pottery evidence also dates the Ed-Deir structure to the 3rd dynasty and while Swelim believes it was an OK RMC (Swelim 1987a: 38), the lack of internal apartments refutes this claim, as it is one of the first elements undertaken when building an RMC. Instead, the date, design, dimension, material choice and location of the structure means it shares many similarities with the series of minor step pyramids built across Egypt during the 3rd dynasty (see Chapter 8).

The Meydum Pyramid

The Meydum Pyramid shows three distinct constructions stages, all of which have been commonly ascribed to Snefru, based on the fact that his name is the only royal name found at the site and on dates left by masons that seem to fit only with his reign length (Stadelmann 1980). Snefru's name was mentioned in a later OK graffito on top of the pyramid and in numerous NK graffiti in the mortuary chapel (Petrie *et al.* 1910: 9), his name was given to the site 'Snefru Endures' (Lehner 1997: 97) and tomb inscriptions indicate that many members of Snefru's family were buried in the neighbouring cemetery – the first of this kind (Porter and Moss 1974: 90-4; Stadelmann 1980: 442-6; Roth 1993). Masons' marks found on fallen blocks of limestone occasionally record a date (Posener-Kriéger 1991: 17-8), notably years 16, 17 and 18 'of the cattle count' which correspond to regnal years 30-31, 32-33 and 34-35. The highest potential date corresponds to years 45-46, which is also the highest recorded at Dahshur North (Posener-Kriéger 1991: 19). If we accept the evidence from the Turin Canon, which states that Snefru's reign lasted 48 years, congruent with the dates from his two pyramids at Dahshur, and Huni's was 24 years, then the dates found on blocks at Meydum can only be attributed to Snefru (Stadelmann 1980).

However, evidence suggests that Snefru may have been only responsible for part of the Meydum RMC and that a predecessor, possibly Huni, may have started the monument. An initial causeway that was almost completed before its abandonment is a well-known feature of the complex. This causeway was filled and buried with debris the stratification of which is the opposite of what the builders would have encountered when digging out the foundations for the pyramid's outer layers E1 and E2, indicating that it was abandoned prior to these phases (Petrie *et al*. 1910: 7). A detailed analysis of the pyramid has shown that E1 and E2 were not different building stages, but planned together from the start as double-casing and that an earlier pyramid that is different enough from the rest of the masonry in form, construction method and building material is most evidently a distinct tomb of an earlier phase (Petrie *et al.* 1892: 5-9; Lauer 1963: 296, 1967: 241, note 4 p. 241; Maragioglio and Rinaldi 1964: 10-2, 36). E0, which is often ignored in discussions about the monument despite being noted in reports, is a square-based three-step pyramid (52.8 m) built with masonry that is more compact than that of the rest of the masonry and formed of undressed limestone blocks cased with fine, dressed limestone blocks (Petrie *et al.* 1892: 5-9; Maragioglio and Rinaldi 1964: 10-2, 36; Lauer 1967b: 241, note 4 p. 241). Furthermore, while the subsequent inward inclined layers that form the steps of E1-2 and E3 are all bonded together, those of E0 are not (Maragioglio and Rinaldi 1964: 10-2, 36; Lauer 1967b: 241, note 4 p. 241). The fact that the abandoned causeway leads straight to the centre of the pyramid nucleus most certainly indicates that the first causeway and E0 belong to the same building project/phase. The difference in placement between the old and new causeways is so slight, with the first requiring much more work and finish than the second, makes the abandonment of the initial causeway remains puzzling, especially considering that the only improvement of the second is that it is slightly more perpendicular to the pyramid, but easily explained if Snefru reworked an earlier structure (Petrie *et al.* 1892; Maragioglio and Rinaldi 1964: 10-2, 36; Lauer 1967b: 241, note 4 p. 241).

In light of the above, it is noteworthy that the builders' marks are found on blocks of the 2nd and 3rd building phases, E1-2 and E3, and that Snefru's name is never mentioned alongside them, as is the case with his two pyramids at Dahshur (Stadelmann 1987: 230; Posener-Kriéger 1991: 18). Hence it is possible that Snefru is associated with these two later building phases only (Lauer 1967b). The OK and NK inscriptions from the mortuary temple are only proof that Snefru was *later* associated with the Meydum RMC, which is to be expected if he completed it and further indication that the name of the original owner was 'lost' (Maragioglio and Rinaldi 1964: 6; Edward 1993: 78; Parra Ortiz 1996). Regarding Stadelmann's (1980: 442-6) argument that if Huni had started the complex, members of his family would be buried there too, as Snefru was the instigator of pyramid cemeteries (Roth 1993), it is logical to find members of Snefru's family and dignitaries in the cemetery, and not Huni's. Finally, the fact that Snefru did not take over the contemporary votive/ritual area of the mortuary chapel, leaving the two stelae bare is intriguing (Petrie *et al.* 1892: 8). Snefru felt he could lay a 'claim' on the pyramid through building inscriptions that, let us be reminded, no one was intended to see, and the environs, with the creation of the first pyramid cemetery. He did not however do so on the most ritually charged part of the complex. While it could be argued that he died before this could be done, given the state of completion of the RMC overall, it would have been simple to leave a couple of craftsmen in charge of finishing the two stelae. Perhaps attribution of the monument was as hard then as it is now.

Hence, as far as the evidence goes, while Snefru's name is the only one present in contemporary evidence at Meydum (Maragioglio and Rinaldi 1964: 6), the archaeological and architectural evidence does point to three distinct construction phases, but not the standard ones. Notably E0 was a three-step pyramid built with its own rock-cut causeway, possibly belonging to a predecessor, stages E1-2 acting as aggrandisement of an original monument, into a seven and eight step pyramid, possibly acting as double casing and then E3, which transformed the stepped pyramid in to a perfect one. Although this remains speculative, a dual ownership would make sense of what some have put forward, notably that no king, even one as powerful as Snefru, could have had three pyramids of the dimensions of the Meydum and Dahshur ones built. The architectural and archaeological record, and the patterning of Snefru's name across the monument support this idea. The fact that RMCs are missing for known kings of this period, notably Huni, may support the idea that E0 belonged to him, as he was Snefru's immediate predecessor and likely father with Huni's secondary queen (Maragioglio and Rinaldi 1964: 10-2, 36). While this remains tentative, such ties and the negotiation of Snefru's identity and/or legitimisation could explain a re-use of Huni's monument, the absence of Snefru's name alongside the mason's inscriptions, and the cultic area of the chapel. Still, the possibility that another unknown ruler of the late 3rd dynasty, such as Nebka/Zanakhte, was responsible for E0 at Meydum should not be excluded.

A Missing 3rd dynasty RMC at Dahshur

A relief slab depicting a king named Horus Qahedjet, possibly Huni's Horus name, which possibly came from Dahshur, could indicate the presence of a 3rd dynasty funerary structure at Dahshur, the existence of which is supported by two 3rd dynasty alabaster sarcophagi found in a tomb near Senwsrt III's MK RMC (Vandier 1968; Porter and Moss 1979; Seidlmayer 2006: 121).

The Great Pit or the Unfinished Pyramid at Zawyet el-Aryan

The date and ascription of a second unfinished pyramid at Zawyet el-Aryan, known as the Unfinished Pyramid or the Great Pit, is also uncertain. Even so, there seems to be a general consensus, based on the inscriptional and architectural evidence, that the structure is one of the missing RMCs of the late 4th dynasty (Lauer 1963: 301-302; Maragioglio and Rinaldi 1967) and this is the view taken in this study. Although very little remains of the complex, which was abandoned at an early stage and is now out of reach in a military zone, the name of its owner was found painted in red ochre on a number of blocks thrown back into the pit after the tomb's abandonment (Barsanti 1911; Lauer 1963). The reading of the name poses problems however because one of the hieroglyphs is unique in form, but the name has been translated as Nebka (used hereafter in this study) with other renderings also proposed such as Neferka, Nebkara more frequently Wekemka, Maka, Bikka, Baka and Horka (Barsanti 1911: 61; Petrie 1924: 45; Černý 1958: 25-9; Lauer 1963: 34-5; Roth 1991: 132-4). The name has been equated by some with a 'Nebkara' who preceded Huni on the Saqqara king list in the 3rd dynasty (Lauer 1963: 306), with Neferka the last ruler of the 3rd dynasty in the Turin Canon (Maspero 1906: 257; Černý 1958: 25-9; Lauer 1963: 24) or with the 'Neferka' given as one of Teti I's successors in the Turin Canon (Montet in Lauer 1963: 310). Although there are limitations to dating a monument based solely on architectural style (Edwards 1994), the design of the tomb, the large open-trench technique used for the substructure that is identical to that seen with Djedefre's, the structure's planned dimensions, the size of the masonry blocks and the use of granite make a late 4th dynasty date more likely (Lauer 1963: 292; Edwards 1993; Lehner 1997: 139). To this one might add the tomb's location north of the capital and the name of the pyramid 'Nebka/Neferka is a star', which is similar to Djedefre's 'Djedefre is a constellation' (Montet in Lauer 1963: 310). Although the name is still debated, the evidence altogether strongly suggests that the Unfinished Pyramid at Zawyet el-Aryan was built in the later part of the 4th dynasty.

Mastaba el-Faraun at South Saqqara

Inscriptional evidence from the mortuary temple attached to the Mastaba el-Faraun strongly suggests that the RMC belonged to Shepseskaf, later considered the last ruler of the 4th dynasty, the only king of the OK not to choose a pyramid for his superstructure. The fragment of a statue was inscribed with the end of a cartouche that ended with the sign for the letter *–f* and was preceded by a square-shaped symbol that most certainly reads *–ka* (Jéquier 1928; Maragioglio and Rinaldi 1967: 134). A stela from the MK indicates that, at least by then, the local cult was dedicated to Shepseskaf (Maragioglio and Rinaldi 1967: 134). Architecturally, the structure dates to the OK. Only two kings of the OK have names that finish with *–kaf*, Shepseskaf and his successor Userkaf later considered the founder of the 5th dynasty. However, Userkaf's tomb has been clearly identified north east of Djoser's complex at Saqqara (Lauer 1965; El-Khouli 1978, 1985). Although of a later date, in one inscription identifying Shepseskaf's tomb, the determinative used after his name is not a pyramid but a symbol that clearly depicts the outline of the stone mastaba, suggesting that his tomb being a mastaba rather than a pyramid was a known fact (Jéquier 1928: 24, fn 4).

2.5. Summary

In summary, RMCs have inspired a long history of research. The conspicuous nature of these monuments and the dearth of textual evidence for the ED and the early OK has made RMCs particularly appealing structures, especially for those who wish to gain insight into the society that built them, especially into institutions of kingship and the early state. Yet, analytical discussions geared towards understanding the role RMCs played in early Egyptian society focus on OK RMCs, minimising the potential that contextualisation with their earlier counterparts could enable. Such discussions also consider developments visible in the shape, layout, scale and decorative program of RMCs, providing useful information, but none have done so in a manner that also considered them in conjunction with patterns of locational and material-use. As such discussions have set aside what location and material use can offer, especially when brought together, about the role these monuments played in early Egypt.

CHAPTER 3

MATERIAL LANDSCAPES AND SOCIAL LOGISTICS

This chapter expands briefly on the discussion in Chapter 2 of the limitations in existing research. I then present alternative perspectives, which are prioritised in subsequent chapters. I stress that we should seek to go beyond simple considerations focused on size, shape and layout and develop a more explicitly landscape and materials-based approach to RMCs during the late ED to the early OK.

3.1. Social Scope

It has been suggested that the building of tombs in early Egypt brought people together in important ways (Hoffman 1991: 327) and that the ongoing construction of these monuments was a ritual activity that may have been considered just as sacred as the finished structure itself (Baines 1995, 1997: 126; Lehner 2004). Taking a wider view of Egyptian history for a moment, it is significant that every time the central state collapsed, regional centres re-emerged, with one eventually reinstating the state system in a way that underscores the co-dependency of the central authority on smaller socio-political factions (Cruz-Uribe 1994; Castillos 2009). The degree to which the central authority relied on these sub-regions for its power and how this relationship was managed, potentially through the materialisation of more abstract notions which building projects enabled, is at the heart of my landscape- and materials-based analysis. To address limitations of earlier research, my research builds on the notion of RMCs mattering not only for the afterlife but also for the process of contemporary rule. Two researchers who have already highlighted the potential of the available evidence but whose work so far has addressed RMCs directly are Anne Macy Roth (1991, 1993, 1998) and Elizabeth Bloxam (2000, 2004; Bloxam *et al.* 2009; Bloxam and Storemyr 2002). Both have inspired the present research as a means to overcome the present biases in emphasis and method.

It is generally accepted that from the 4th dynasty at least, groups of on-site builders at RMCs were organised via a long-established social system (Eyre 1987: 11-8; Roth

1991: 61-74; Dobrev 2003; Lehner 2004) nowadays referred to as the phyle system of which Roth (1991) has provided by far the most important discussion (see Chapter section 2.3). While the social structure behind these groups is rarely expanded upon in discussions of RMCs, the fact that earliest evidence for phyles coincides with the start of the 1st dynasty suggests that (a) the system is tightly connected with the emergence of the state and (b) that the system was used to organise the workforce involved in the running of state affairs (but also potentially other institutions such as local cults) with the *wr* phyle, being the most prestigious and possibly the closest to the royal institution. Inscribed stone vessels from Abydos and Saqqara suggest that at least in the ED each group had its own ceremonial equipment (Roth 1991: 86). Evidence also suggests that phyles had hereditary membership and initiation ceremonies, a practice that seems to have continued throughout the OK, with each phyle having its own storeroom in RMC mortuary temples (Roth 1991: 205-6). There is no direct evidence that phyles as we know them in later periods existed in the Predynastic, but for Roth (1991: 192-3), the Predynastic use of animal emblems to distinguish social groups, along with the hereditary structure and initiation rituals of later phyles, suggests that phyles originated from Predynastic kin-based groups who expressed a corporate identity through totemic symbols. According to this argument, phyles may have originated as extended family or local groups, belonging to a small elite that was most likely centred around Abydos and/or Memphis, the ancestral and new homes of kingship (Roth 1991: 205-6). By the 5th dynasty, the priestly phyles that organised the building and maintenance of the royal cult included high-ranking officials that also held other functions, such as overseer of works or architect, suggesting that by then the phyles existed across social classes (Dobrev 2003: 29). The system of a rotating phyle workforce, mentioned in Chapter 2, enables optimal use of labour while allowing time for rest and, perhaps more importantly, for all five phyles to benefit from service to the king and the king to benefit by integrating an existing elite and the hierarchy beneath it (Roth 1991: 207; Jones 2006: 30).

Building on this notion of kin groups but paying greater attention to off-site quarry workers, Elizabeth Bloxam and colleagues (2009) have been effective in overturning the traditional idea of a workforce consisting of thousands of unskilled workers, and instead have offered a new model for the social organisation of hard stone quarrying expeditions outside the Nile valley. In this new view, such expeditions were carried out by small groups of skilled stone-workers "loosely structured around kinship ties within well-developed social identities". The groups were possibly dispatched from a specialist centre in Egypt much as the ornamental stone-workers based at Luxor in Egypt are today (Bloxam *et al.* 2009). Altogether, the evidence and discussion Roth, Bloxam and colleagues provide brings to the forefront a social context to building for stone architecture. This is precisely what the present landscape and materials based approach is designed to build upon for RMCs in particular.

Another goal of this research is to rebalance our assessment of mudbrick versus stone construction. While largely valid in terms of the observed sequence, the idea of an evolution from softer to harder materials reflects art historical perspectives about 'natural' progression in material use (Ingold 2007) and has meant mudbrick has been assumed by modern commentators to have been a poorer, more primitive material (Kemp 2000). As a result, mudbrick has been largely ignored (Reisner 1931: 69-89; Spencer 1979a) and there has been no systematic study investigating material use in greater detail that could help shed light on the shift from mudbrick to stone in RMCs. This bias in archaeological interest is also exacerbated by the better preservation of stone monuments and the fact that the type of inscriptional evidence available for the organisation and social fabric of the stone workforce (by virtue of the material) is absent for ED and OK mudbrick monuments. In contrast to stone, our current understanding of ED and OK mudbrick workforces is based on later Middle and New Kingdom evidence, modern day parallels and the erroneous notion that mudbrick production is easy, requiring an unskilled and commonplace workforce. This perspective has limited our understanding of what it meant, practically, socially and symbolically, to build with mudbrick in the ED, when it was the prime construction material, but also risks missing out on the meaning attached to patterns of material use in later stone RMCs as well.

As a result, virtually nothing is known of the social context of mudbrick production and construction. Captions accompanying the NK tomb scenes of Rekhmire state that the labourers making the bricks were foreign captives, and this has led to the widespread view that coercion was used to guarantee the necessary output of mudbricks for large-scale projects (Davies 1943: 54-5; Lucas 1962: 63; Spencer 1979a: 3; Kemp 2000: 83). However, just because one NK vizier (Rekhmire) mentions the use of foreign captives does not mean that this was always the case (Davies 1943: 54-5), and particularly for ritual structures built in a period when mudbrick was the building material *par excellence*, such as the royal tombs at Abydos. Also, because mud is considered a cheap and universally accessible material, the industry is often seen as a form of unskilled, peasant labour that has remained unchanged since antiquity, with no involvement of those with official titles, as was the case in stone production. The social context of mudbrick production and construction in the ED may have been very different. Very little has been done to develop methods that enable us to link systems of mudbrick production visible in the ethnographic record or in other archaeological settings to the archaeological record of early Egypt. My research will address this in Chapters 6 and 9. Returning briefly to phyles, one explanation for the lack of evidence for phyles being involved in mudbrick architecture is that such a system was not required to organise the mudbrick workforce; another explanation is the very different nature of mudbricks as an inscriptional medium that may have made it less likely for inscriptions of phyles/work organisation to survive. The possibility that the use of phyles for royal mudbrick architecture might be visible in the archaeological (rather than the epigraphic) record is something returned to in Chapter 9 with regard to Khasekhemwy's RMC.

Whilst very few commentators have addressed the OK mudbrick workforce on its own terms, there is nonetheless a considerable amount of disparate evidence that can be marshalled. Composition testing of mudbrick, which enables us to draw conclusions about the character of the workforce, has only been carried out at a very limited number of later NK and Late Period sites (French 1981, 1984; Morgenstein and Redmount 1998; Emery and Morgenstein 2007). Prior to this study, composition testing had never been done for ED or OK RMCs. The analysis of a Late Period mudbrick enclosure at El Hibeh in Middle Egypt provides our first good information on the spatial organisation of a mudbrick workforce as it may be gleaned through compositional analysis (Emery and Morgenstein 2007). By analysing the grain size, mineralogy and strength of mudbricks and local sediments, Emery and Morgenstein (2007: 115) revealed two geochemically distinct mudbrick groupings in the north-east and south-west of the structure. This clear spatial division of labour has parallels in the stone architecture of the OK RMCs discussed in Chapter 2, as well as with the working strategies of NK mudbrick workers based near Luxor at Deir el-Medina (Emery and Morgenstein 2007: 118-20), and it demonstrates the potential of the composition testing also used here (see Chapter 6, 9 and Appendix B).

3.2. Landscape and Materials-based Approach

A landscape approach to RMCs enables us to bring a wider scale to the assessment of these structures that complements existing considerations of monument shape, size and basic positioning, providing further contextualisation of these projects within their economic, social and symbolic world (see Chapter 4, section 4.3 for definition of landscape). It does so by considering each monument within its immediate and wider natural resource and cultural setting, providing a temporal and geographic breadth to RMC building activities and exploring how the particular unfolding of logistical tasks might have practical, social and symbolic implications. As such, this wider context takes us beyond any top-down bias that might focus exclusively on the king or a single elite group (Bloxam and Storemyr 2002; Bloxam *et al.* 2009). It also helps us go beyond a sole focus on the Memphite region RMCs or the Abydos ones that might otherwise be encouraged by the biased nature of the existing archaeological record and later historical periodisation into dynasties. When combined with a materials analysis, a landscape approach enables a more dynamic understanding of what it meant to build these structures.

Applying landscape and materials-based approaches to RMCs enables further contextualisation of the building process. As mentioned in Chapter 2, very little attention has been paid to the choice and positioning of construction materials in RMCs, or to the wider implications surrounding their source. When considered at all, such issues have usually been addressed from a practical perspective, focusing on stone primarily and especially on relative volumes and labour cost, as well as to a lesser degree structural properties and availability (Stadelmann 1983; Trigger 1990; Lehner 1997: 202-12; 2004; Mallory-Greenough *et al.* 2000; Klemm and Klemm 2010). The few existing commentaries generally explain change in material selection via a basic evolutionary logic in which societies gradually develop better tools to exploit harder craft materials (Ingold 2007: 10). This avoids discussion about the fact that the physical properties of material, and the manner in which we engage with them reflect social and symbolic values that go beyond economic considerations, something expanded on in Chapter 4 (Boivin 2004b: 65). Only two existing studies of RMCs offer insight into the possible symbolic meaning of stone RMCs and none as yet addresses these issues for their mudbrick counterparts (Hoffmeier 1993; Spence 1999).

3.3. Logistics, Society and Ideology

A further point to make is that material culture is not just reflective of society, but actively structures social dynamics, something returned to in greater detail in the following chapter (Renfrew 2001: 126; Boivin 2004a,b; Ingold 2007). The landscape and materials-based approach to RMCs adopted here is designed to help us explore ways in which RMC building may have been instrumental to state consolidation. To achieve this, two interpretive frameworks are brought together in this research that are otherwise traditionally considered as lying at opposite ends of a spectrum of value with regard to location and materials: logistics on the one hand and symbolic meaning on the other. The dearth of explicit inscriptional evidence explaining why certain materials were used in architecture and the difficulty associated with inferring symbolic meaning from the archaeological record has meant that only a few studies have so far explored the symbolism of materials as a possible factor in patterns of material use in RMCs (Aufrère 1991: 695; Karlhausen 2000: 42-3). Yet, given the symbolic meanings vested in shape and layout of RMCs and that which is recognised for material use in other contexts or later monuments, a growing number of commentators recognise that while practical considerations were paramount in how materials were used for RMCs (Stadelmann 1987; O'Connor 1992; Hawass 1995) a similar degree of symbolism must also have been associated with the construction materials. This is something increasingly recognised for stone and is particularly visible when certain harder varieties of stone were selected to embellish a particular feature in a way that served no structural purpose and received no wear, such as a burial chamber's wall and floor lining; it is also relevant to the use of soils for mudbrick (Wood 1987; Arnold 1991; Aufrère 1991: 695-703; Hoffmeir 1993; Spence 1999; Baines 2000; Karlhausen 2000; Love 2000; Mallory-Greenough *et al.* 2000; de Putter 2000; Goyon *et al.* 2004: 105). A perspective that entertains multiple kinds of value opens up ways to understand what individual changes in RMC location and materials tell us about the nature of power and rule as expressed through monumental architecture in early Egypt and go beyond the notion that it is simply the existence of a centralised state that enables this monumentality (Webster 1991). These issues are expanded upon in the two following chapters.

To conclude, in addition to the main research question 'what do changes in the location and construction materials of Egypt's royal mortuary complexes tell us about socio-political change and, in particular, the consolidation of power during the early 3rd millennium BC', three sub-questions are formulated below to help flesh out the spatial and material patterns of RMCs over time and to offer a basic structure for the data-driven analysis in Chapters 6, 7 and 8 as well as the broader discussion that follows in Chapter 9:

1. Spatial patterning: how does the choice of location and construction materials at an RMC relate to its (a) immediate and (b) wider geographical setting?
2. Temporal patterning: to what degree are the choice of location and construction materials of an RMC a response to (a) the predecessor's RMC and (b) a deeper royal funerary tradition?
3. What are some of the logistical, social and symbolic implications associated with the patterning of RMC building activities and how could these contribute to state consolidation?

A landscape and materials-based approach enables us to discuss developments in RMCs in more holistic terms by building on previous, often more disparate research. It enables us to consider the complex yet potentially powerful interconnection of the logistical, economic, social and symbolic dimensions of the decision-making that went into the construction of these important structures, and to better understand how instrumental RMC building was for state consolidation in early Egypt.

CHAPTER 4
LANDSCAPES, MATERIALS AND BUILDING ACTIVITIES:
THEORETICAL APPROACHES TO MONUMENTS

4.1. Introduction

This chapter introduces some important theoretical concepts that help frame a more contextual, landscape- and materials-based approach to monuments and will be followed by discussion in Chapter 4 of the methods by which such an approach may be implemented. In the light of developments made in other fields of archaeological research, it is argued here that, while monuments act as displays of political power (Trigger 1990), they also act as platforms for active social interaction and political negotiation from the planning and construction stage onwards (Hamilton *et al.* 2008). Looking at RMCs as building projects, rather than only as finished tombs and temples (Ingold 2000: 188; Hamilton *et al.* 2008), helps us to focus on the impact that certain design choices, such as a monument's location and construction materials, had on relationships between the ruling elite and wider society, especially as accessed here via greater attention to the workforce. Monuments in my research are treated as large orchestrations of material culture through which ideological concerns are negotiated and contextualised at the landscape scale. It is in this broader context that RMC building offered strong integrative potential for a wider Egyptian society and played a role in the consolidation of state ideology. The first part of the discussion below reviews some existing ways in which monuments are traditionally thought to relate to society and power while the second part suggests opportunities to build further on these views.

4.2. Monumental Display and Social Complexity

Economic considerations have long dominated discussions of the role of monuments in the process of state formation and consolidation not least because of the assumed link between increasingly complex society, greater inequality and more restricted access to material resources. By seeing monuments as economic, it becomes possible to see how specific choices in the design of an RMC may have contributed to changes in the way a society is organised, or at least the way in which the ruling elite wished to present itself to a wider audience. Some continue to consider this control of energy, including natural resources and labour, the most fundamental and universal basis for power (Trigger 1990: 128; see also Abrams 1989; Aranyosi 1999; Neiman 2008).

Monuments often require vast amounts of material resources and human energy, as well as planning and management of work crews (Abrams 1989; DeMarrais *et al.* 1996: 18). Hence economic approaches to understanding these structures have long been favoured (Erasmus 1965; Trigger 1990). While the term 'conspicuous consumption' was initially used to refer to the ostentatious displays of newly wealthy industrial elites (Veblen 1899), it has also been applied to the ways in which certain elites expressed political power through the building of monuments. Such models of consumption are sometimes assigned more tightly economic or energetic scores by considering thermodynamics "or the study of the transformation, conversion, and movement of physical energy through a system" (Abrams 1989: 52; see also Trigger 1990). In this view, the power of monuments lies in the fact that their building contravenes sensible human principles of least effort, as more resources and energy are put into a single structure than its function would strictly require (Zipf 1949).

RMCs are certainly acts of conspicuous consumption, since they were designed to bury a single individual, but consume lavish amounts of resources, both human and natural. In this view, the economic expenditure and control that monuments represent make them symbols of power through which an unequal social order is legitimised (Abrams 1989; Trigger 1990). Restricted access to resources is essential for exerting political power through ideology. Kings in complex societies often displayed their power by building big and fast (Feldman 1987; Earle 1991b). Also, it is generally thought that where population can be taxed in the form of corvée, monuments are more numerous and larger than in places where the population cannot be taxed in such a way (DeMarrais *et al.* 1996: 19). From this perspective, monumental architecture allows the ruling elite to express, maintain and/or increase their social standing, by confirming social inequalities (Veblen 1899; Trigger 1990; Aranyosi 1999; Neiman 2008: 169).

In very practical terms, a thermodynamic approach to monumental construction often involves explicit measurement of construction costs (in terms of person hours, calories, etc.) and making educated guesses about what these costs meant for a society. As such, a thermodynamic approach to monuments is useful because it does highlight a concrete aspect of building activities: how relative cost considerations might influence the design of architecture (Abrams 1989: 48-50). Labour-cost estimates, which are derived from the volume of material and correlated with the expenditure of time and the tyranny of distance, provide quantitative insights into the economic and logistical implications of monument building. Although it is possible that a king was unaware of the exact, total labour-costs involved in these projects (unlike today where everything is valued by labourers' hourly wages; Shanks and Tilley 1987b: 46-65). Also, the control of labour confers political control. Economic approaches remain very appealing and insightful, as they are based on very concrete and measurable energetic considerations.

Turning away now from such highly practical considerations, for the reasons given above and developed below, rulers in complex societies are often identified as builder- or creator-gods (Helms 1986, 1993: 77; Wengrow 2004). The act of building expressed the ruler's ability to construct cosmic order. Although there is no builder-god *per se* in Egypt, throughout much of Egyptian history up to the Roman period, kings were often associated with creator gods who were themselves depicted as patrons of various crafts (e.g. Khnum who was depicted as a potter fashioning humans on his wheel using silt and water; or Ptah patron of all craftspeople, at least in later periods; Sandman Holmberg 1946; Goyon *et al.* 2004: 110). Mark Lehner (2004: 12) speculates that, "perhaps building the pyramid was considered as much a sacred ritual as the daily services in the temples". Rituals pertaining to building activities were recorded very early on, from the very first kings of Egypt alongside cattle count and measurements of the height of the flood, some of the most important activities for the king (Wilkinson 2000). Depictions, such as on the scorpion mace head from Hierakonpolis and from Snefru's valley temple at Dahshur, and entries on the Palermo Stone commemorate foundation rituals, such as the stretching of the cord, confirming that building rituals were important acts the king carried out with the assistance of deities (Fakhry 1961: 94-7; Millet 1991; Park 1998; Wilkinson 2000). Such symbolic imagery illustrates a more general point that Rapoport (1980) makes about architecture being a way to organise and justify social inequalities. In this perspective, it is argued that the act of building becomes inscribed in a powerful nexus of communication between leaders, gods, or the unfathomable forces of the cosmos and the rest of the population, which altogether represents a dynamic that may be described as a vertical axis of political ideology and cosmology (Helms 1993: 81). In the case of Egypt, the type of building considered in this study is even more compelling in that the monuments in question, tombs, are places designed to make sense of the otherwise very unruly and chaotic experience of death. The king as maintainer of order is a very old motif that goes back to Egypt's prehistory (Kemp 1989). Monuments suggest that the king imposes orderly structure onto a landscape that is both natural and social, in a manner similar to accessing, controlling or transforming powers of the cosmos through symbolic and technical knowledge, creating ideals that are both political and aesthetic (Duncan 1990; Helms 1993: 78).

It is useful to use and refine such economic approaches by taking into consideration other factors, such as locational choices, the types of materials used as well as the reuse of sites, materials and monuments. For instance, a structure could be smaller, yet have required large volumes of materials from a source further away from the site than a larger structure built with large volumes of locally available materials, making the smaller structure more costly and difficult to acquire and work. This is especially so if, as is the case with RMCs, the structure in question is built further in the desert or at a higher elevation than others that are closer to the cultivation and the river (the latter being the main acquisition route for off-site materials in early Egypt), at a lower elevation, and that uses more local materials.

4.3. Monuments in the Landscape

Landscape archaeology, which now constitutes a sub-discipline of its own in archaeology, provides an umbrella term under which falls a range of approaches to the human use of space, some of which offer a useful way to go beyond thermodynamic approaches by further contextualising monuments (Thomas 1993: 20). Two main themes of landscape archaeology that have influenced this research are reviewed below. These consist of (a) the movement of people around the monument and around a wider resource catchment for the monument, especially the workforce, and (b) the deliberate placement of monuments in the landscape, which may relate to the isolated choices made for a single monument or concerns to respond to existing monuments and a longer historical tradition. In this thesis, the term 'landscape' refers to a wider physical and material environment formed of permanent and transient, natural and man-made features. Landscape theory refers to a general framework that places monuments and human activities in a physical and socio-economic context via a network of connections that are spatial and temporal, but also social and cultural (Ingold 1993; Hood 1996; Johnston 1998; Crumley 1999; Edmonds 1999a,b; Knapp and Ashmore 1999; Stoddart 2000; Blake 2001: 150; Thomas 2004: 167-73).

Landscape approaches highlight how central an understanding of spatial relationships between local sites, other activity areas and wider regions are for understanding past societies. Ingold's (1993, 2000) concept of 'taskscapes', which are the set of spatial and temporal relationships between activities in a certain area, offers a useful way to look at monuments in the context of their construction, whether it be the building site or a remote quarry. Specifically, taskscapes expose how resource-use can be mapped through space and time in a meaningful way (Hood 1996). By bringing attention to the physical and temporal backdrop behind different tasks, they underscore the set of relationships that exist between people, places and materials in time.

Looking at monuments in the context of their activity areas also highlights the existence of different scales of activity, here broken down for practical purposes into 'local' (e.g. a few kilometres around the site itself), 'regional' (e.g. in the same Egyptian province) and national (spanning the whole geographical extent of Pharaonic Egypt). Each scale offers a way to qualify the types of economic and logistical undertakings that link a monument to different places, or sources, at different interaction distances (Ingold 1993; Hood 1996). The concept of a multi-scalar resource landscape is particularly useful in the context of a study of monuments built during state consolidation as a means to gain insight into different types of economic relationships.

However, in the past 20 years, landscape archaeology has shifted its understanding of landscapes and human activities from purely economic and ecological considerations to ones emphasising how landscapes help to create and are created by certain cultural perceptions (Aston 1985: 91; Edmonds 1990a,b; Tilley 1994, 2004). Landscapes are no longer thus purely physical environments acting as mere backdrops to human behaviour nor are the traces of human activities only considered economic and pragmatic (Aston 1985: 91). Instead, landscapes and the human activities that unfold within these are an ordering of space that is cognitive and symbolic, and that humans continuously build and rebuild (Ingold 1993; Thomas 1993: 28-29, 2006: 43-4; Bradley 2004a; Wexler 2011). It is also an ordering that can to some extent reflect the multivocality of cultural perceptions (Layton and Ucko 1999: 3). This is a particularly useful approach in the context of state consolidation, as it foregrounds possible socio-political strategising between different segments of society through economic relationships (Ingold 1993; Hood 1996). In this thesis, landscapes are viewed as large-scale artefacts of past human activities that can give us some idea of how building projects such as RMCs relate to key strategies and worldviews, which is relevant on its own terms, but also helps us make up for a dearth of contemporary textual evidence.

A landscape approach also highlights how the deliberate placement of a monument might contribute to ordering social relationships, something which is key during periods of political transition (DeMarrais *et al.* 1996). Monuments mark boundaries and/or centres and can often act as nodes along axes of communication (Flannery 1876; Edmonds 1990a,b; Bradley 2004a; McFadyen 2008: 308). Monumental architecture is a means of communicating information at a large scale to a wide audience (whether viewers or contributors) across a broad territory and in a way that potentially goes beyond language, gender, class and time. Choice of location and construction materials may tie in with a desired elite discourse but also with the identities of the wider communities associated with a place and may remind communities of their connection with ancestors and kinship, and this may be manipulated to express, or create, more overarching relationships of authority (Richards 1996; Jones and MacGregor 2002). Monumental architecture communicates to an audience both within and outside a given society, to those involved in ritual activities taking place within these structures, but also to those directly involved in the building of the monuments (Abrams 1989: 48; DeMarrais *et al.* 1996; Thomas 2004: 174-5). Monuments, which are less prone to change than more ephemeral ceremonies or portable objects, act as permanent markers and expressions of ideology and as such communicate in a permanent and enduring manner that transcends the life of the individual (DeMarrais *et al.* 1996: 19; Richards 1996; Thomas 2004: 177). Monuments often represent the power of a ruling authority in an unambiguous way and the spatial distribution of monuments in the landscape reflects the type of power being claimed (DeMarrais *et al.* 1996: 29). Therefore monuments can strengthen the attachment a group has to a land through a sense of temporal longevity and permanence that may be heightened with an emphasis on funerary structures designed to transcend death and make it a controllable aspect of life (Flannery 1973; Wilson 1988; Parker-Pearson 1993, 1999; DeMarrais *et al.* 1996: 19; Richards 1996; Graham pers. com. 2014). Those cases where monuments *are* reused and modified, however incrementally or slowly, as is the case with some Egyptian RMCs, may further reveal attempts to revise or improve traditional ideologies of power within established ideological frameworks. Monument building at times contributes to the formation of cumulative palimpsests whereby the present reworks the past (Bailey 2007).

Looking at monuments from a landscape perspective highlights how a structure fits in a network of existing physical, economic and social connections that, in the case of states, are vertically but also horizontally organised, a notion returned to in the final section of this chapter (see section 3.5). Looking at monuments from a landscape perspective reminds us of the plurality of voices potentially involved in their creation and how their successive accumulation through time led to the formation of cultural landscapes that the archaeologist can attempt to uncover part of at least (Brumfiel 1992, 1995; Richards 1996; Attema 2002; Hamilton *et al.* 2008: 17).

4.4. Monuments as Large-Scale Orchestration of Materials

Studies have increasingly shown that the selection of specific materials and their ordering across a landscape in the form of a monument often also reflects functional, economic and symbolic priorities (Owoc 2004; Parker-Pearson 2004). For example, particular attention has been paid the use of material in prehistoric monuments in western Europe (Sherratt 1997; Parker-Pearson 2004; Scarre 2004a,b) and other studies (Taçon 1991; Bradley 2004a) offer useful themes to discuss the significance of material choice. Several commentators have already pointed out that symbolic values seem to have played a major role in material selection in both domestic architecture and ritual structures, one that at times surpasses functional or economic logics (Boivin 2004a: 65; Scarre 2004a,b; Meskell 2004: 249). The more narrowly economic approaches to monuments discussed earlier in this chapter tend to assume that the moment a ruler or community has the technical ability to muster the resources for large-scale consumption, more costly materials will automatically be selected for monumental architecture.

However, certain properties contribute actively to how humans engage with the material, such as where in the landscape one needs to go to get it or what actions need to be done to use it. As discussed in Chapter 2, stone's durability, compared to that of more perishable materials, makes it suitable for weight bearing and protection from wear in architecture for instance but such a property also makes stone an ideal symbol of longevity, permanence and possibly for the concept of eternity (Aufrère 1991; Bradley 2004b; Helms 2004). Other inherent criteria such as colour and provenance (as well as grain, texture, iridescence though these will not be considered in this thesis) have also been identified as major properties that influence human engagement and give materials symbolic value: thus when materials imbued with such distinctions are used across a monument they can build more complex meanings (Hoffmeier 1993; Postgate 1997; Spence 1999; Owoc 2004; Scarre 2004a,b; Taçon 2004; Ingold 2007).

Studies of material use in monuments have so far focused primarily on stone, most likely because stone architecture leaves a permanent and conspicuous trace in the landscape (Sherratt 1997; Scarre 2004a,b). Yet, there is also a growing interest in earthen architecture that sometimes suggests a similar symbolic impetus whether for ritual or domestic purposes (Boivin 2004a,b, Owoc 2004, Parker-Pearson 2004, Taçon 2004). Ethnographic studies of material use in rural communities in India and Africa, as well as material use by aboriginal communities in Australia, show that materials such as stones and soils are commonly seen as sacred, powerful and at times even animate and that these symbolic values are relevant to their use in architecture (Boivin 2004a,b, Owoc 2004, Parker-Pearson 2004, Taçon 2004). This type of symbolic use of materials in architecture has also been argued widely for pre- and early state societies and helps rectify a common bias of western thought that construes materials as passive, inanimate and devoid of symbolism other than that attached to the cost of their acquisition (Boivin 2004a).

While monuments are commonly considered as status symbols and markers, landscape studies are proving how useful it is to investigate such structures in parallel with archaeologies of natural places and the strong relationship that exists between material use and place (Johnston 1998; Stoddart 2000; Bradley 2004a: 41; Scarre 2004a,b; Thomas 2004: 165). The source of a material can play an active role in its symbolic value and use in architecture. In particular, materials may be used as ‘pieces of place’, where characteristics of the source location are symbolically invoked to help build an ideological discourse around a larger-scale construction (Pearson 1998; Bradley 2004a: 81; Saunders 2004: 124; Scarre 2004a,b). Pearson’s (1998) commentary inspired by performance theory is relevant here as certain objects or materials can be thought of as parts that stand for the whole (i.e. as metonyms). Certain geographical regions or landforms can at times hold very specific meanings in the minds of communities, with these able to be transferred to substances found at these locations and thence to portable objects and built structures (Edmonds 1999a,b; Bradley 2004a: 88). For some, the transfer of meanings from source to material (and sometimes back again) allows construction of microcosms of wider landscapes, and in some cases, a "re-engineering" of the cosmos (Thomas 2004: 179). The symbolism associated with the geographical origin of a material, whether the latter comes from a local or remote source, near the heart of the state or at its borders, from an area of fertile cultivation or arid desert, might all be aspects worth considering when attempting to understand the symbolic reasons for selecting a particular material rather than something else (Scarre 2004a,b). Bringing materials from the perceived corners or edges of a territory, for example, may be seen as ideologically powerful, and there is arguably a link between the displacement of people and the displacement of material, both of which "conceptualise the physical geography of the empire" as will be discussed in the following section (DeMarrais *et al.* 1996: 29). The way in which materials were transported and reassembled could have been exploited to bring together and connect places, and their communities, that were distant physically, but also a way to domesticate the wild and distant (Cooney 1999: 50).

Two New Kingdom Egyptian examples illustrate the above points well and, if treated with due caution, can indicate the general kinds of meanings that might have existed in earlier phases of Egyptian history. First, limestone supposedly from Tura in the north of Egypt was used for the mast bases of pylons in the northern part of the temple of Karnak at Luxor while granite from Aswan in the south of Egypt was duly used for blocks in the southern pylons (Barguet 1962: 54; Karlhausen 2000: 46). Second, the statuary found in the northern parts of Amenhotep III's mortuary temple is made of quartzite and travertine from the north while those in the southern parts are made of granite from Aswan (Barguet 1962: 54; Bryan 1993: 76; Karlhausen 2000: 46). Such choices reflected and reinforced the political importance of the north and south distinction. In the New Kingdom, Egyptians also used provenance tags alongside their mention of materials: hence there are instances of limestone known as the 'white stone from Tura' and granite as 'the stone from the Island of Elephantine' (Aufrère 1991: 703). Travertine is also often referred to in relation to one of its main sources at Hatnub (Harris 1961: 77; Aston 1994: 44; Shaw 2010: 14) and such tags clearly demonstrate that place was an importance way to categorise what might otherwise be thought of as raw materials.

A final example from a later period that it is worth highlighting by way of introduction is quartzite, which was used in RMCs from the 5th dynasty onwards, and is one of the only stones for which there exists a sufficiently explicit text to tell us about the meaning vested in this material and why it may have been used in artefacts and architecture. A later Ptolemaic document shows us how the Egyptians drew upon solar and Sethian theological beliefs combined with ancestral notions of order's victory over chaos to explain the provenance, colouration and texture of quartzite from the Gebel Ahmar (Red Mountain) quarries located 9 km south of Heliopolis, on the east bank (Aufrère 1991: 699; Yoyotte 1978: 148-50). The mention in the text of provenance, colour and physical properties are of particular value to us, as they are observable and retrievable today in the material record (Yoyotte 1978; Aufrère 1991; Quirke 2001). Quartzite from Gebel Ahmar ranges from a whitish cream colour to purple-red, sparkles, and occasionally presents inclusions of pebbles, gravel and fragments of silicified wood (Yoyotte 1978; Quirke 2001). The Ptolemaic text explains the mythical creation of a spectacular vein at this location as the place where Seth's dismembered and calcinated body lay after perishing in his attempt to murder the ageing sun god Re. The red stone became connected with the sun cult and a symbol of this god's victory over the chaotic forces represented by Seth (Yoyotte 1978: 148-50; Aufrère 1991: 700-1). Although this cannot be proven, another characteristic of the stone that may have contributed to its solar association – in addition to colour, sparkly grain and location near Heliopolis – is the luminescence created upon striking the stone (triboluminescance) as a result of the tool's friction against the stone's constituent silicified quartz sand grains, as is the case in a number of other societies (Scarre 2004b: 200). Indeed, physical aspects attached to different manufacturing stages have been shown to confer symbolic meaning to materials (Helms 1993; Edmonds 1990a,b, 1999; Boivin 2004b; Scarre 2004b: 200). The case of quartzite, along with some of the points raised in Chapter 3, stresses the usefulness of investigating material symbolism as it is associated with human interaction with matter, by using broad categories, such as locational and physical/working properties, that are retrievable today from the archaeological record. The reasons quartzite was not used as a building material in RMCs prior to the 5th dynasty remain unclear. However, the advent of sun-temples in the 5th dynasty suggests that its use may be linked to a rise in prominence of the already important sun-cult (Quirke 2001).

Acts of material extraction and crafting are often also considered powerful, potentially very ceremonialised, acts (Helms 1993; Bradley 2004a; Boivin 2004a,b; Parker-Pearson 2004; Saunders 2004; Scarre 2004a,b). Under certain circumstances, craftspeople can be perceived as powerful agents because they manipulate, enhance, release or simply shape the concept, power or divinity associated with a material. Miners and quarrymen may sometimes be seen as rather mundane roles, but we should at least explore evidence for an alternative world view in which they are engaging in powerful ritual encounters in places where multiple environments or worlds meet (Bradley 2004a). In these cases, the material is symbolically valuable even before being transformed into an object or used architecturally, and the act of extracting or crafting the materials adds further value and meaning (Jones and White 1988; Helms 1993, Boivin 2004a: 5; Saunders 2004). In societies that present such beliefs about materials, the introduction of a new material is not always a break-through innovation, but often an extension or a reworking of millennia-old beliefs and practices (see section 8.2; Helms 1986; Saunders 2004: 124) and this will be shown in future chapters to be particularly relevant to mudbrick. Interestingly, in Egypt, the word for 'sculptor' literally translates as 'he who keeps alive' (Meskell 2004: 250) and tools belonging to sculptors were often found buried with members of the elite which should at least give us pause for considering that sculpting might sometimes be a revered act (i.e. at Meydum, Petrie 1892; Petrie *et al.* 1910). One of the first known viziers and architects, Imhotep, who served under Djoser, was chief sculptor (Hurry 2000) and was later deified.

4.5. Monuments as Building Projects

Building on the social contextualisation explored in the previous sections, the final part of this chapter emphasises the advantage of considering structures as more than fixed, finished constructions, but instead as developing, sometimes re-initiated, building projects (Ingold 2000; Hamilton *et al.* 2008). More exclusively and traditionally economic approaches to monuments have tended to encourage a top-down understanding of power dynamics that commonly depict monuments as clear indexes of social complexity and a workforce involved in these projects as large, passive and enrolled through coercion (Tilley 1984: 143; Shanks and Tilley 1987a: 49; Trigger 1989: 341-2; Feinamn 2000: 50-1; Bloxam 2004; Hamilton *et al.* 2008; Bloxam *et al.* 2009). Whereas in certain circumstances, slavery may be the most advantageous method by which to build a monument as it requires very little investment for a ruler, in more long-term situations, coercion is often not a valid means of securing power because it typically forges poor social relations (Shanks and Tilley 1987a: 180).

Research shows that processes of negotiation were often key during periods of state formation and consolidation, and that certain states found alternative ways of establishing themselves by engaging their followers through recruitment in building projects (Giddens 1979; Guksch 1991; Cruz-Uribe 1994; DeMarrais *et al.* 1996; Bloxam 2004: 177, 2006; Brumfiel 2004; Rowlands 2004; Castillos 2009). Large-scale communication bringing people from different segments of society and parts of the territory together during the reign of an individual ruler for monument building can be highly effective. Co-opting local and non-local groups, or systems of knowledge, helped establish hegemony by creating or reinforcing the link between different communities while at the same time creating a form of co-dependence on the state through building activities (Shanks and Tilley 1987a,b; Jones 2006). Also wider mobilisation of a workforce beyond a specialist group draws people from across the social spectrum, from different communities and from various cultural zones, to work on a central, communal project (Eyre 1987; Lehner 2004). The fact that skilled craftsmen often have to travel to remote places outside the ordered and civilised world to acquire the materials they need (certain soils, metals, stones and woods) means that they, as a group, can sometimes also be associated with the powerful supernatural forces of the other outside realms (see section 4.4.). This integrative way of securing the power has been described as an absorption and transferral of aesthetic labour (Wengrow 2001: 88).

While there is also an obvious pragmatic interest in being able to move specialists that for instance are able to work hard stones to the geographically distant and remote quarries to extract the stone and then work it on the construction site, the ruling elite benefited from the display of power that came with sponsoring such endeavours and associating with prestigious and powerful craftsmen (Helms 1993: 32-4; Bloxam *et al.* 2009). Monumental architecture is often seen as the "outward demonstration of feats of coordinated effort" to the extent that the power of monuments may not have been the reserve of the planners but also the worker (Bloxam 2004: 154). Such a model is particularly viable in a socio-political context in which persuasion and consensus may be more realistic tools (Wengrow 2001: 88; Kus and Raharijoana 2004) as has been argued for state formation in Egypt (Cruz-Uribe 1994; Castillos 2009).

Traditional thermodynamic approaches perhaps too narrowly imply that monuments emerge when there is a strong and centralised political system already in place (Hodder 1986: 18-25; Webster 1991). However, in some cases, less complex societies that do not have a strong centralised social and political system have also built large structures. These might be scheduled to allow for only low levels of labour input over long time periods: effectively as work in progress (Earle 1991b; see also Feldman 1987). Amongst others, this has been argued for the Nurage in Sardinia (Webster 1991), certain Neolithic communities in Western Europe (Sherratt 1991, 1997) and some Moche ceremonial centres in South America (Hastings and Mosley 1975). Abrams' calculation of labour-days for the stone Temple of Meditation in Honduras suggests that the building imposed very little labour stress on society and required a small number of specialists from the elite and their cooperation with a well-organised groups of non-specialists that were part of the lower segments of society (Abrams 1987: 495). Hence monumental architecture does not always require complex social organisation or centralised political systems (Flannery 1972; Yoffee 1979; Abrams 1989: 50; Webster 1991; Sherratt 1991, 1997).

In cases where large-scale monument building is present in pre-complex societies it appears that kinship ties were a major component for organising the workforce involved (Abrams 1987: 496). Kinship ties clearly continue to be important features in many complex societies, particularly during periods of state formation and consolidation (Guksch 1991; Roth 1991; Brumfiel 1992, 1995; Cruz-Uribe 1994; Crumley 1995; Campagno 2000; Castillos 2009). In Egypt, the close connection between kinship groups, phyles and kingship may hint at a similar process in which the integration of smaller social groups became an essential, positive aspect of monument building (Roth 1991). 'Horizontal', heterarchical social orderings often coexist within 'vertical', hierarchical systems and, in the context of states, the former often involve social groups that predate the centralised state system, but which tend to disappear from view once centralised political systems emerge (Brumfiel and Earle 1987; Brumfiel 1992, 1995; Crumley 1995). The notion of heterarchy seems appropriate to the early Egyptian context and in particular the period under discussion. Every time the centralised system collapsed in Egypt a more provincial, kin-based social system re-emerged (Cruz-Uribe 1994; Campagno 2000). Heterarchical systems can be a useful way to discuss social dynamics reflected in RMCs building in the period under study, as such alternative social organisations may never have fully disappeared but may have been integrated into a more centralised and overarching system. Negotiation within these heterarchical factions may have been central to state authority, as they potentially acted as intermediaries between the state and the rest of the population, especially within the context of large building projects. The planning and building brought together specialists and non-specialists and created large-scale places of social production and reproduction; navigating possibly awkward social relationships would have been particularly significant during periods of state formation and consolidation (Sherratt 1997; Bloxam 2004; Bloxam *et al.* 2009). Archaeologically, such social interactions can be considered by looking both at place and material use of monuments.

Studies that hone in on the detailed sequential, spatial backdrop of production and construction acts encourage us to think carefully about decision-making processes and the social context of building (Hood 1996; Knapp and Ashmore 1999; Stoddart 2000; Hamilton *et al.* 2008). One of the ways of looking at a project's logistical chains spanning different regions and social groups is to take inspiration from and draw upon priorities of the body of theory known as the *chaîne opératoire*. Chaîne opératoire is used traditionally to trace the joined-up sequence of production steps for an artefact such as a lithic tool (Edmonds 1990a,b; Schlanger 1994). Here, however, chaîne opératoire theory is extended to monument building in two ways: (a) the decision-making behind a monument, which means understanding each monument in relation to how it departs form or is similar to preceding one(s), and (b) the logistical chain associated with materials, something which Edmonds (1990a,b) termed "material biographies". Hence, the contention here and in later chapters is that, via reconstructions of the spatial and temporal coherence of tasks associated with the choice in location and construction materials of a monument, it becomes possible to place the whole sequence of events surrounding technological activities in a clearer social context (Pfaffenberger 1988: 25, 1992; Edmonds 1990a,b, 1999; Dobres 1995: 26, 1996, 2005). Although such studies cannot be used with the same resolution that artefact studies enable, they act as a useful complement to the coarser grain of landscape approaches and will be addressed in Chapter 5.

4.6. Summary

There is a growing interest in understanding how monuments contribute to the building of states rather than simply how states build monuments (Lehner 1997, 2004; Love 2006a,b, 2007). The fact that a king in Egypt seems to have started to build his tomb immediately after coming to power and that in some cases the project was only completed some time after his death (Edwards 1993; Goedicke 1995: 32; Spence 2000; Wilkinson 2000) suggests these projects were ideal platforms for social interaction and structuration, and worth extending for as long as possible. From this perspective, it becomes possible to understand the role RMCs played in the formation and consolidation of a state system in early Egypt, during a time in which increasing social inequality could easily become a point of contention between different groups in society. The strategies influencing the design of an RMC potentially reflect communication between the ruling elite and different social groups, and the landscape and materials-based approach to RMCs adopted in the chapters that follow allows us to explore how these monuments were not only important displays of political power but also makers of society (Brumfiel 1992, 1995, and it is with these ideas in mind that we can now turn in Chapter 5 to questions of method.

CHAPTER 5
RESEARCH METHODS

The theoretical discussion offered in the previous chapter has already anticipated the nature and scale of the main datasets and research methods outlined in detail in this chapter and used in later chapters. The objective of this research is to (a) provide a detailed diachronic, site-by-site assessment of changes in location and building materials used in RMCs built in Egypt between 2,700-2,500 BC and (b) discuss the patterns in terms of some of their possible logistical, social and symbolic implications (Chapter 9), in a way that builds on previous research, as outlined in Chapter 2. Underlying the approach is the assumption that building activities act as material platforms for negotiating wider social issues, and actively contribute to aspects of social reproduction and transformation, especially in the context of state consolidation, and that this can be accessed to some degree via a review of choices of location and building materials. The framework presented in this chapter is inspired by research methods devised for both cross-cultural and Egyptian studies, as reviewed in Chapters 2 and 4, and adapted here to the context of early Egyptian RMCs. The chapter will introduce the main dataset, the locational and material parameters of the approach, the field mudbrick analysis developed for the purpose of this study, and finally the parameters of the historical contextualisation and the limits of this research.

5.1. Main Dataset

The main dataset comprises 17 structures built in Egypt over a 200-year period, including 14 RMCs assigned to 13 known rulers (see Appendix A) and two ancillary enclosures, here considered as extensions of the first RMC this study considers, Khasekhemwy's. These RMCs are built across eight sites (fig. 1.1). Six are in the north of Egypt, in the vicinity of Cairo, and from north to south are known in modern Egyptian as Abu Rawash, Giza, Zawyet el-Aryan, Saqqara, Dahshur and Meydum. Meydum is set apart, 45 km south of the southern border of the tighter northern cluster and may be considered as part of Middle Egypt, a geographic distinction occasionally made in the literature and which will aid in the discussion this thesis presents (Chapter

9). These sites form a 72 km stretch of built landscape. Two sites are in the south, at Abydos and Hierakonpolis, and provide information for the earliest structure this thesis is concerned with. All RMCs are located on the west bank of the Nile in what is today the low desert, relatively close to the modern cultivation (maximum 2 km).

The data collected for each RMC consists of locational and material information obtained through published site reports, maps, satellite imagery and fieldwork. While the bulk of the data is macro-scale (i.e. distances, topography, volumes, building materials etc), to remain systematic across both mudbrick- and stone-dominated RMCs, with the two materials categories exhibiting different properties, it proved necessary to generate microscale data through a compositional analysis of mudbricks that employs microscopy. This was carried out on the single mudbrick-dominated RMC accessible during the course of my research, notably that of king Khasekhemwy, whose RMC is the first monument this thesis examines.

5.1.1. Locational Information

Locational information is recorded systematically for each RMC to characterise its immediate locational setting and help situate the monument within its wider landscape. Hence, the information collected traverses (a) the site scale and (b) the inter-site scale. The data recorded at the site level consists of topographical information such as elevation, topography and geology, and a number of spatial relationships that connect the RMC to places of interest in its immediate natural, resource and cultural setting, such as distance to the river, local wadi and quarries. The inter-site level describes farther-reaching connections, such as to the political capital, previous RMCs, shrines or any other significant feature or place in the landscape, and distance to off-site sources of construction materials. Spatial relationships are described as local (e.g. a few kilometres around the site itself), regional (e.g. in the same Egyptian province) and national, (spanning the whole geographical extent of Pharaonic Egypt) in scale and offer further contextualisation in terms of (a) logistical setting and access to resources, both natural and human, and (b) connection to places of cultural and symbolic interest.

As such, a systematic collection of locational parameters provides context that helps us better understand the setting of an RMC by emphasising a number of enabling and/or constraining factors. Recording and analysing the sets of locational parameters individually for each RMC makes it possible to see how individual RMCs respond to, or refute, the statements made by the immediately preceding RMC and those before it. The locational information also provides a spatial and temporal backdrop to a material-based analysis, as the location of a building site has implications for the types of materials used, their volumes and the organisation of work.

Fleshing out locational parameters and spatial relationships helps us understand some of the implications that a particular geographical setting has for the building of an RMC in terms of logistics but also in terms of symbolic concerns. Shifts and continuities in the ways in which successive RMCs relate spatially to one other and other key places in the natural and cultural landscape may well be part of a discourse that has some symbolic bearing and into which the elite tapped to communicate to a wider population either witnessing and/or contributing to the monument's construction.

5.1.2. Material Information

Material information is recorded systematically for each RMC. The information concerns (a) the RMC's overall shape, dimensions and layout, as well as any noticeable building stages and/or secondary modifications, and (b) the types, volumes and spatial arrangement of construction materials. By identifying these dimensions for each RMC it is possible to trace trends over time and to see how each RMC responds or not to previous RMC design. Considered in the wider context of the locational information collected, the material data helps us better understand building logistics and possible symbolic concerns.

Building stages and design modifications are a recurrent feature of Egyptian architecture. Changes in design relate to changing priorities of engineering, varying access to resources, both human and natural, and royal ideology. Changes in design reflect stages in the building of the monument carried out before or after the RMC's completion, either during the reign of a king or after, thus are the result of a ruler or his successor's decision-making. As such, building stages and design modification are important for the final interpretation of the data. Also, the degree of completion of a monument is important to consider, as it highlights the fact that not all RMCs were finished. RMCs are here described either as unfinished, completed, as in the basic architecture is built, or finished, i.e. the finishing touches that are not essential to its functioning. By determining what has been built and what has not at each RMC, it is possible to comment further on specific building stages and the temporal and spatial organisation of work. The building sequence tells us about architectural priorities, in terms of what needed to be built first. Combined with material information, this also helps us determine what materials were removed, left in place or newly introduced to the site when a monument was finished by a successor. As such, a materials-based approach to RMCs can help us build on previous approaches that consider generally only the completed monument and its life post-completion, by paying attention to the sequence of construction or the construction stages of a monument, and the actions required for these.

The data collected for the construction materials of each RMC relates to,

a) The types of construction materials used, such as reed, wood, mudbrick, limestone, fine limestone (harder- and finer-grained than other varieties of 'softer' limestone), granite, basalt, gneiss and travertine,
b) Rough estimates of volume for each material category
c) The use or function of construction materials within the RMC, i.e. whether for structural (masonry, beams) or for finer architectural decoration.

Material characterisation can be thought of as a large-scale, monumental orchestration of materials across both the landscape and a monument, through time. Across the monument specifically, material characterisation entails identifying a material's placement in relation to different architectural components (e.g. supporting or just cladding the burial chamber) and differential visibility. As such, material characterisation sheds light onto practical/logistical and symbolic uses, but can, as outlined in Chapter 4, also get us closer to accessing social contexts of production. For this reason, the material information from each site is further refined with data about the specifics of use of each material, something coined 'material biography' following Edmonds 1990a,b.

Material Biographies

In order to assess the relationship that exists between site location and material use in RMCs, it is essential to establish the working parameters governing the use of each material used in these structures. Edmonds (1990a,b) offers a useful concept for this, that of material biography, which he devised for chaîne opératoire (operational sequence) artefact studies (French archaeologist André Leroi-Gourhan was the first to propose the concept of chaîne opératoire; see Leroi-Gourhan 1957). Broadly speaking, material biography refers to the cultural life of a material and the chain of one or more cultural actions applied to it from source to final use and deposition. In terms of a practical application of this concept in the context of this research, it has been necessary to modify methods initially developed for the chaîne opératoire of artefact production (for example Lemonnier 1986, 1993, Edmonds 1990a,b) to better suit the nature of the record and scale of RMCs. Material biography gives a sense of the sequence of production through understanding of the spatial and temporal coherence of tasks. By highlighting the cultural life of a material from the perspective of production and technology, we get closer to technological expertise and the possible social context of production attached to a material (Edmonds 1990a,b).

There are limits as to how precisely we can reconstruct the exact chain of events, or manufacturing sequence, that surrounds a material's use. Reconstructing manufacturing sequences remains more problematic for the artefact studies that have inspired the chaîne opératoire than they do in the case of much larger-scale analysis of monuments. A rough outline is sufficient at this stage, as it gives an idea of the spatial and temporal requirements surrounding the consumption of different materials in monument building. Also it is important to bear in mind that the physical properties used to reconstruct production strategies are often derived from modern building standards and may not always accurately reflect the logic and understanding of Egyptian workers 5,000 years ago. Still, modern building standards provide a useful way to begin to understand some of the parameters governing the use of different types of materials in RMCs. The material biographies of mudbrick and stone differ significantly as a result of their inherent physical properties. Material biographies pay attention to production parameters and aesthetic values, and evidence for these can be collected from archaeological reports, experimental archaeology and modern reports on materials. Production parameters and aesthetic values will be used to refine the site data in the final discussion (Chapter 9). Some of the parameters considered are reviewed now in greater detail to give a better idea of what these entail.

Production Parameters

Extraction and acquisition methods are important to consider. For instance, for stone this means considering whether stone was conveniently collected as small boulders, or, when larger units were required, stone was quarried. Was the surface of the stone for instance removed? Break patterns, grain type, presence or absence of tectonic joints, degree of homogeneity and hardness were all exploited to various degrees by the Egyptians because they eased or complicated the task (Aston 1994; Mallory-Greenough 1999; Aston *et al.* 2000; De Putter 2000b; Mallory-Greenough *et al.* 2000; Bloxam 2007). It is worth considering tools and methods of extraction as well as what work was carried out at the extraction site, en route or at the final building site. Typically it is best to remove as much of the weight as possible to facilitate and reduce the cost of transportation but also to leave enough to protect the core. Such parameters make the extraction of certain stones highly specialist endeavours (Mallory-Greenough 1999; Mallory-Greenough *et al.* 2000; Bloxam 2007). The modern interest in Egyptian stone-working means that the methods of extraction and acquisition of stones such as limestone or granite, their general use, and their particular use for OK RMCS are well established. Their general use and their particular use for OK RMCs are well established (Stocks 1986a,b, 1999, 2001, 2002, 2003; Arnold 1991; Mallory-Greenough 1999; Mallory-Greenough *et al.* 2000; Klemm and Klemm 2001, 2008, 2010; Bloxam 2007.

Considering a material's source helps to determine how accessible a material is by outlining a number of parameters regarding acquisition. These parameters may be shared across different materials, or may be unique. Source and accessibility determine transportation from the extraction site to the building site. The parameters considered in my research are (a) whether the material comes from a single source or multiple sources, (b) the geographical location, (c) topography and (d) possible transport methods. For stone, topography at the extraction site is a major factor of accessibility, either as a constrainer or facilitator. If a source is located near the cultivation valley or far out in the desert on top of a hill, this will impact the acquisition process. It is also useful to determine whether the material is transported over land or by water, in which case it is important to determine whether the material travelled up or down stream, and whether there are seasonal restrictions. Transportation routes and method vary according to the source's location as well as the distance, terrain, volume, size of the units and the type of material. Based on textual evidence, by the 6th dynasty members of the elite oversaw the transportation of materials by boat; it is likely that elites oversaw the acquisition of materials earlier on (Eyre 1987: 13-5).

Practical considerations shed light on the technical, spatial and temporal requirements of building with different materials. They also shed light on those stages where there is a need for specialists or non-specialist groups. Physical properties can be measured and therefore form a quantifiable dataset that is useful to trace trends visible across different RMCs over time. Such calculations, however approximate, act as a good complement to the less quantifiable, but equally important, data pertaining to a material's aesthetic and symbolic properties.

Aesthetic and Symbolic Values

To help access aesthetic and possible symbolic considerations, aspects such as colour, grain, texture, shine, patterns, veins and inclusions for instance have all been shown to be important for material selection in monumental architecture. However, in mudbrick RMCs the bricks are generally, although not always, covered over with either organic material, such as wood planks or reed matting, or plaster and paint. The presence of coatings meant the mudbricks were invisible once the monument was finished and therefore does make the question of their aesthetics perhaps more debatable than for stone, which was left apparent. Consequently, the aesthetic criteria for mudbrick are investigated in terms of inherent colour, but also in terms of the texture of plasters and colour of paints whenever possible. Although preserved cases are few, they are extremely informative about the use of colour in architecture in particular, something returned to in Chapter 9. Also, aesthetic qualities of soils may have been viewed as an indicator of quality of the soil and an important initial selection criterion in manufacturing quality bricks. Aesthetic qualities, such as a blackish colour, may perhaps have been synonymous with certain religious or symbolic conceptions, such as fertility, the inundation or seasonal cyclicality and I will offer evidence in favour of such an argument in later chapters.

Studies of material use in artefacts and to a lesser degree in architecture in general in Egypt show that primary and secondary textual and iconographic sources can be used with caution, as a starting point to develop an understanding of the symbolic qualities associated with different construction materials used in royal funerary architecture (Karlhausen 2000). Although evidence contemporary with the monument is always preferred where available, it remains scarce for the period under study, and the studies mentioned in Chapters 2 and 3 (sections 2.2 and 3.3; see especially Wood 1987; Arnold 1991; Aufrère 1991: 695-703; Hoffmeir 1993; Spence 1999; Baines 2000; Karlhausen 2000; Love 2000; Mallory-Greenough *et al.* 2000; de Putter 2000; Goyon *et al.* 2004: 105) show how later sources and secondary literature can be used with a measure of caution. As mentioned, inferences about ideological qualities may be drawn from the Egyptian word for a particular material itself, as this often gives some indication of the qualities the Egyptians ascribed to the materials, whether due to its source, colour or texture. The range of qualifying vocabulary relating to the material in question may also be informative, whether it is diverse or limited, and what features it relates to in particular. In terms of archaeological evidence, it is useful to record the role of a material in artefacts and architecture, as well as the first recorded contexts of use. As discussed in Chapter 4, the embodied, sensory engagement humans have with materials suggests that a whole range of actions surrounding the extraction, transportation and crafting of a material and its specific physical properties may also have had symbolic implications. Such provenance may entail whether particular shrines or natural features in the landscape are associated with such a source, whether the source is in the desert, mountains or near cultivation, close to a territorial border or core of a territory, but also source availability (e.g. whether seasonal or not), manufacturing properties, whether extraction is an additive or subtractive process, the materials hardness, softness, ductility, degree of polish or finish possible and/or skill required. Therefore, determining a material's provenance may all be able to tell us about certain ideological qualities associated with the materials used in RMCs.

As part of a materials-based approach to RMCs, an emphasis on material biographies has the advantage of refining our awareness of material consumption in RMCs, especially when considered jointly with locational setting. Even though material biographies remain tentative modern reconstructions, they recognise both practical and symbolic aspects of material use, both of which seem to be ever present in past people's minds, particularly in such symbolic architecture as the monumental tombs built for the early kings of Egypt. As such, material biographies help us build on traditional approaches that until now have been limited to the calculation of volumes of material. In particular, material biographies bring into focus the relationship the RMC has to its wider resource landscape and broaden our understanding not only of the organisation of work and the workforce but also of possible symbolic values that may have been vested in aspects surrounding material use.

5.2. Field Mudbrick Analysis

Due to the more limited research on mudbrick architecture compared to stone monuments (see Chapter 2), additional data collection is required for mudbrick RMCs. A novel method of compositional analysis has been developed (in close consultation with established geoarchaeologists) for the purpose of this study to gain insight into the composition of mudbricks, shedding light on the sourcing of materials and the organisation of work (see Appendix B for detailed description of the protocol). Hence, while the lowest resolution considered in this research for stone architecture is a single block (e.g. for the calculation of volumes of different stones), for mudbrick architecture, it is the individual micro-components that go into the making of a brick sample. Just as different materials are brought together to form a single stone monument, a mudbrick monument requires the bringing together and binding of different materials even before the building of the monument starts, and it is this stage that is most interesting, as it has the potential to tell us about decision making, resource access and organisation of work. Therefore, it is necessary to go to a scale of analysis that is smaller, or narrower, than that of the artefact to understand the implications of building with mudbrick.

Compositional information is essential for understanding the use of mudbrick in RMCs as it enables us to assess the sourcing of individual materials and the manufacture of mudbricks. Mudbrick, unlike stone, is the result of an additive process that requires bringing together different material components selected from both natural and anthropogenic settings, and their correct mixing into a paste. Stone in contrast requires cutting, or subtracting matter from the stone. The distinction made here is concerned with human involvement. Obtaining the right paste texture is paramount in brick-making and a skill largely determined by expertise and knowledge of materials and source. Essentially it reflects an expert sense of sediment textures and the properties of possible tempers, something this study highlights. Texture indicates the quality, costs and labour time that went into brick-making and provides insight into the decision-making process. Comparing grain size distribution with an assessment of mudbrick colour, sand sorting and a basic microartefact analysis of the sand grain size across different structures makes it possible to refine our understanding further of the decision-making process and the organisation of labour involved in the construction of different structures across sites and through time. Comparison also helps to determine different production units and building strategies. It is possible to generate data regarding the composition of mudbricks by combining a grain-size analysis with a textural and microartefactual study. Compositional information is particularly useful when combined with archaeological, historical and ethnographic evidence on the subject. Because compositional information helps shed light on the spatial and temporal organisation of the workforce called upon for these projects, it becomes possible to gain a better understanding of the logistics and possible symbolic use of mudbrick in royal mortuary architecture.

Although it would have been preferable to test all extant mudbrick structures systematically at RMCs spanning the full time period of this study, given the time constraints of the current project, this was not feasible administratively or practically. It was decided to focus on a comparison of two near-contemporary monuments at Abydos and Hierakonpolis, built under a single king of the second dynasty, Khasekhemwy (2,700 BC), to provide major contextual information for the bulk of the later stone-dominated RMCs, and using the scanty, wider evidence from other RMCs for further comparison. It is also particularly pertinent to focus on these two structures, as the Khasekhemwy RMC at Abydos continues a long-established tradition of building RMCs with mudbrick. As such it is more likely to give us insights into the significance of the royal use of mudbrick as the main material in a firmly established tradition, rather than mudbrick being secondary (used less and for hasty completions), as in later stone-dominated RMCs. A smaller number of comparative samples were taken from earlier, contemporaneous and later funerary structures, mostly form Hierakonpolis and from Khasekhemwy's predecessor's monumental enclosure at Abydos. No domestic structures could be sampled, although these would have provided valuable comparative material to further refine the analysis, something discussed further in Chapter 9. Fortunately, other tombs could be sampled for comparative purposes. The data from these analyses are provided in Appendix C.

Even so, the analysis presented in the following Chapter 6 on Khasekhemwy demonstrates how essential compositional analysis of mudbricks is to our understanding of RMCs and mudbrick in general. The insights are particularly valuable for our understanding of the first 200 years of monument building in Egypt, when other evidence remains limited, and the later stone-dominated traditions then emerged from older practices. By analysing the composition of mudbrick, we are able to make use of one of the most conspicuous elite and non-elite datasets available in Egypt to further our understanding of the role this material played and still plays in Egyptian society. The microscale data generated for mudbrick composition were generated during two field seasons in 2009 and 2010 and stored as a relational database. Composition patterns will be presented via bar charts and ternary graphs. A brief description is given below. For a detailed description of the procedure, please refer to Appendix B.

The field analysis may be broken down into four distinct stages. A total of 55 mudbricks were sampled, the location of each sample is recorded, 17 from Khasekhemwy's enclosure at Abydos and 33 from his enclosure at Hierakonpolis.

a) A brief textural description of the mudbricks samples is carried out, recording colour, paste homogeneity and texture, and types of inclusions.
b) A rough grain size analysis was carried out in the field. This enabled me to determine the composition, quality and variability of mudbricks by establishing the ratio of clays, silts and sand in a mudbrick. By looking for uniformity or its absence across a monument, it is possible to get an idea of the organisation of labour and landscape use (Rosen 1986; Professor Arlene Miller Rosen and I developed the method that is derived from a technique used to extract phytoliths from sediment samples and after having discussed sampling with other archaeologists interested in the topic elsewhere in the world.)
c) A description is provided of the sand-size grains and their sorting (Bullock *et al.* 1985: 26), which tells us about sourcing of materials.
d) The above is combined with a basic microartefact analysis of the sand size grains, which also tells us about sourcing.

Data Collection and Management

The macro-scale, locational and material data collection involve systematically recording information for each RMC site and monuments, from detailed site reports, maps, plans and satellite imagery. Maps and plans were used to calculate spatial relationships, dimensions and volumes of material. Short fieldwork seasons were carried out in 2006, 2009 and 2010 to crosscheck and ground-truth the locational and architectural information, collect GPS points for RMCs and any relevant associated places of interest, such as quarry sites, and also generate microscale analytical data about mudbrick composition for Khasekhemwy's monuments, the details of the method of analysis of which are given later in this chapter. Plans for each RMC were digitized and all other data are stored and managed in a database (Microsoft Excel).

5.3. Socio-Historical Contextualisation

Additional data pertaining to socio-political history, such as reign lengths, events, names of kings and RMCs, and site histories were collected and mostly drawn from existing publications on inscriptions, texts, iconography and archaeological finds. Reference to primary sources is made whenever possible. This makes it possible to reconstruct a historical and cultural landscape to help situate and contextualise early building activity.

Published information about the workforce involved in these building projects is also collected and reviewed, with particular attention to questions of logistical and social organisation. The data collection focuses on the organisation of the workforce at both quarry and building sites, with a special interest in the phyle system, and the relationship the phyle system has to the royal house and building projects, specialist and non-specialist tasks and kinship ties and modes of organisation. Published information pertaining to the workforce is largely limited to stone construction. Therefore, the mudbrick analyses outlined above combined with other archaeological, historical and ethnographic evidence have proven essential to my study of the organisation of the workforce associated with mudbrick architecture, and complements the scarce textual and iconographic evidence. The information on the workforce is used to contextualise the primary observations of the monuments themselves and is an essential humanising component of a landscape- and materials-based approach to RMCs that places the building process at the heart of the analysis, complementing the knowledge we already have of the ruling elite who were at the head of these projects. Looking more closely at the workforce widens the scope of our understanding of these building projects by integrating social classes other than the ruling elite. Looking at the workforce in conjunction with the elite(s) is a direct practical application of a theoretical emphasis on approaching these RMCs as places of social interaction.

5.4. Two-Part Analysis

The data and methods presented are used in a two-part analysis. To suit the needs of a diachronic assessment, the first stage of the analysis presents sequentially, site-by-site, a basic analysis of the locational and material parameters of each structure in Chapters 6-8. The locational and material information of the single RMC analysis contextualises the structure within its broader natural and cultural landscape and is compared principally to (a) the immediate predecessor's RMC, and (b) to a lesser extent, to the wider RMC tradition. The first part of the analysis maps out connections between location and material use in a manner that highlights the logistical implications and possible implications for the workforce. Comparison with previous RMCs makes it possible to trace trends over time and see more clearly how an individual RMC is part of a dynamic cultural landscape.

The second part of the analysis (Chapter 9) offers a thematic discussion of some of the logistical, symbolic and socio-political implications of the long-term trends which the site-by-site case studies provide in Chapters 6-9 for the 200-year period with which this study is concerned. Because there appears to be a social component to the organisation of specialist working groups, collecting the locational and material data and considering it chronologically makes it possible to envisage different types of social organisation of labour attached to different materials, manufacturing techniques and sequences.

5.5. Limitations

There is some difficulty attached to the exact succession of rulers, the dating of certain monuments to specific rulers, and the ascription of monuments to certain kings known from inscriptions, such as Huni's at the end of the 3rd dynasty. Given the diachronic developments and my interest in understanding the intentionality attached to monuments, these problems are significant. Fortunately, historians have satisfactorily addressed the majority of these issues (Lauer 1962; Swelim 1983; Edwards 1994; Dodson 1996, 1998; Kahl 2006; Seidlmayer 2006), making it possible to engage in a diachronic discussion of RMCs, as reviewed in Chapter 2. Chronological difficulties are systematically born in mind and mentioned in the relevant sections of this thesis with alternate scenarios offered where necessary.

There is also some difficulty attached to the fact that some RMCs are largely unfinished, such as the Layer Pyramid at Zawyet el-Aryan, limiting our understanding of the grander design and strategies intended. Others are currently inaccessible, such as the unfinished RMC known as The Great Pit at Zawyet el-Aryan, which is in a military zone and leaves us with very few, old and unsystematic reports. Khasekhemwy's tomb is now covered with sand. Fortunately, detailed reports provide useful information, though little about the mudbricks. Generally, mudbrick descriptions in reports remain highly subjective and are all too brief descriptions, at best providing commentary on mudbricks' dimensions and bonding.

The destruction of monuments in antiquity or in the modern era, for religious or practical reasons such as the widely attested reuse of material, makes it difficult to ascertain the types, volumes and orchestration of materials used. It is common practice to reuse materials, particularly if materials are difficult to obtain in the first place or, equally, if they are reusable or can be applied as field fertilizer, which is high-in-demand in Egypt today. While freak floods contributed to the destruction of mudbrick structures at Abydos (ED RMC superstructures) and Giza (Menkaure's temple), because the structures were situated in wadi systems, many stone-dominated RMCs have been plundered for their dressed stones. Particularly notable is the case of the superstructure at Giza or Abu Rawash, the latter of which was plundered by the Romans and in the 19th century AD; sometimes up to 300 camel-loads were taken away per day (Verner 2001: 222). Now only the very lowest courses remain (Maragioglio and Rinaldi 1966: 30). Destruction of a monument and/or reuse is noted whenever possible.

The above-mentioned limitations must be taken into account when attempting to map out material consumption under a specific king. Yet, given the coarse scale of the analysis, limitations such as destruction and/or reuse pose only a limited problem. The sites still offer locational information and it is also possible to produce rough estimates of how much material was used in a complex, based on what is available from the site, reports and plans. These estimates certainly give an idea of what may have been used in terms of material types and quantities, where the different types of building materials were placed, or intended to be placed. Although clearly fragmentary, the available material information may still be used as a basis for analysis. Also, the major limitation of reuse highlights the importance of the practice, and my study wishes to stress the continuity in the practice of reuse through time as a key feature of these structures, something which may warrant more study in itself, especially in the case of mudbrick. Still, in the context of this study, the practice of reuse may mean that some of the material used at an RMC was also taken from either a predecessor's monument in antiquity, as is attested later with the reuse of OK blocks in MK pyramids (Goedicke 1971), or from the storage yard of a predecessor. Still, remains and reports provide valuable locational and, though more limited, useful material information.

Another limitation concerns the few and often contradictory geological surveys of RMC sites (except for Giza). Fortunately, Klemm and Klemm (2010: 69) provide a basic overview of the geology for OK stone RMC sites. Also, despite the interest in stone, reports frequently misclassify stones (Spencer 1999). For instance, the term 'basalt' is often used to describe siltstone and greywacke from Wadi Hamamat and the non-porphyric granodiorite from Aswan used to make most of the sarcophagi and pyramids of the OK and MK (Aston *et al.* 2000: 24). The term black-granite has been used to describe basalt vessels (Aston 1994: 19). Egyptian Alabaster is actually travertine (Spencer 1980: 17; Aston 1994: 169; Aston *et al.* 2000: 59) and Chephren Gneiss is often called 'diorite gneiss', 'Chephren diorite' or simply 'diorite' while recent petrological analysis has determined that 'anorthosite gneiss' or 'gabbro gneiss' is more appropriate (Bloxam 2004: 125). Thankfully, experts have painstakingly rectified errors over the years (Aston 1994; Aston *et al.* 2000; Bloxam 2007).

Finally, in general, evidence for RMCs is uneven over the time period this study covers. This is due to the fact that the amount of archaeologically preserved written and material evidence increases over time. There have been increases in the amount of building taking place as the dynasties consolidated their authority, and more recording as dynasties developed more complex bureaucratic administration. This means that there is more secondary literature, by modern commentators, available for the 4th dynasty kings and RMCs, than for earlier ones. The methods presented in this chapter are intended to help rectify (a) the focus on OK/4th dynasty monumental stone building and (b) the ED-OK divide. In so doing the methods are intended to help better understand Egypt's early history, and in particular the process of state consolidation, the earliest mudbrick structures and what changes in the archaeological record may actually have meant.

5.6. Summary

Despite the limitations outlined in this last section, the results produced with the present methods of survey and analysis refine our understanding of the logistics and ideological notions attached to these building projects and therefore are intended to offer a clearer understanding of the nature of the relationship between the building of a monument the building of a state.

The primary objective of a landscape and materials-based approach to RMCs is to bring together a disparate set of information on location and material type that are usually treated separately. Together these sets offer insights into what it meant – not just for the elite but for the wider population – not just for the elite but for the wider population - to build RMCs. An approach combining studies of landscape and materials should also contribute to our understanding of the role the building of RMCs came to play in the consolidation of power and state ideology in early Egypt. A secondary objective is to address a persistent bias in the published literature in which attention is focused solely on stone architecture. Investigations need to be widened beyond stone architecture to understand the period under construction.

The first part of my analysis, which follows in Chapter 6, is intended to reveal the potential that lies in a focus on mudbrick architecture in its own right. The chapter has two objectives: (a) assessing the relationship RMCs had to state consolidation, and (b) drawing attention to ways of overcoming the stone bias. The following chapters attempt a more balanced view of RMCs by bridging an investigative and interpretative gap that has been created between the mudbrick and stone traditions in royal funerary architecture. It is also hoped that light can be shed on the logistical, ideological and social realities of building with mudbrick under the first dynasties of kings.

CHAPTER 6
KHASEKHEMWY

The overall analysis, presented in the following Chapters 6, 7 and 8, reviews the locational, architectural and material parameters for each RMC. The information is then brought together in a final discussion (Chapter 9) of the possible logistical, symbolic and social implications surrounding these patterns, in an effort to better illustrate the relationship between the building projects and the developments in political ideology and state consolidation. Chapter 6 begins the chronologically-ordered, site-by-site analysis of royal funerary monuments built in Egypt from the end of the 2nd dynasty to the end of 4th dynasty (2,700-2,500 BC), with an in depth analysis of the first RMC of this sequence. This RMC was built by Khasekhemwy, traditionally seen as the last ruler of the 2nd dynasty, thereby bridging the ED-OK gap (see Appendix A).

6.1. Khasekhemwy's Monuments

Khasekhemwy's RMC at Abydos (Dreyer 1990, 1991, 1992, 1993; Dreyer *et al.* 1996-2008; O'Connor 1989, 1999, 2003; O'Connor and Adams 2005; Adams 2003, 2008) will be examined within the wider context of two additional structures generally assigned to the ruler, a mudbrick enclosure at Hierakonpolis (Friedman 1995, 2005, 2007, 2008) and a stone enclosure at Saqqara (fig. 6.1.a, 6.1.b, 6.1.c; Mathieson 2000; Van Wetering 2004). Each structure is treated individually and in the same systematic manner to examine the ways in which Khasekhemwy's building activities reflect the geographical reach of his power. Since Khasekhemwy's RMC at Abydos and secondary enclosure at Hierakonpolis employ mudbrick as their principle building material, an emphasis is placed on the analysis of this material in this chapter. Similar tests could not be performed on the mudbricks of his tomb at Abydos or those used as a construction aid (platform used for moving bulky material) for the limestone enclosure at Saqqara, as both the tomb and platform are covered with sand. Even so, small-scale compositional data of the mudbricks used for his two southern mudbrick enclosures provides information on the sourcing, manufacture and organisation of the mudbrick workforce in a way that other evidence cannot, offering valuable insights into royal building activities involving mudbrick during Khasekhemwy's reign and providing a context for understanding developments in subsequent reigns.

It has been suggested that a number of rock-cut galleries under Djoser's complex were potentially part of a funerary complex that Khasekhemwy may have had at Saqqara (Stadelmann 1985). However, due to paucity of supporting evidence, these rock-cut galleries are not included in the present discussion. As far as the locational and material trends indicate, the building logistics of Khasekhemwy's structures may be described as designed for or geared to multiple, large-scale projects that are essentially local in scope. The following paragraph reviews our current understanding of the political situation as a context for building activities before moving on to Khasekhemwy's RMC at Abydos.

6.2. Abydos

As mentioned in Chapter 2, the royal cemetery at Abydos was not in uninterrupted use throughout the ED. At least two, possibly three, royal tombs are attested at Saqqara for the earlier part of the 2nd dynasty, each presumably marking a break with the earlier Abydos tradition and involving a shift of investment to the north (Reisner 1936; Munro 1983, 1993; Lacher 2011). The fact that the founder of the 2nd dynasty and of the first royal necropolis at Saqqara in the north, Hetepsekhemwy, oversaw the burial of the last king of the 1st dynasty (Qa'a) buried at Abydos, indicates that there was no real break between the 1st and 2nd dynasties (Dreyer *et al.* 2000: 11). The same appears to have been the case with the transition from the 2nd to the 3rd dynasties (Dreyer *et al.* 1996). Hetepsekhemwy's name, which means 'the two powers are at ease', may support the hypothesis. Alternatively, his name may indicate that there was some political strife that required shifting the royal necropolis north, perhaps to make 'the two powers at ease'. As such, the shift to a new northern necropolis may have been logistically advantageous but also prompted by socio-political reasons.

The reasons Khasekhemwy's immediate predecessor Peribsen returned to the 1st dynasty royal cemetery at Abydos are unknown, but the move has often been interpreted as a sign that two separate governments had re-emerged in the north and south of Egypt, and that Peribsen's power was limited to the south (Dodson 1997).

Although some warn against the assumption that the shift was politically motivated (O'Connor 2009: 156), the historical and archaeological evidence outlined below, including Khasekhemwy's building strategies, as we shall see (Chapter 9), do seem to support the notion that some sort of fissure or change occurred in the central government prompting a temporary return to Abydos by Peribsen and Khasekhemwy (Friedman 1999: 9-11). This change may or may not have been accompanied by building in the north at Saqqara (Stadelmann 1985; Van Wetering 2004). Yet, Khasekhemwy was the last king to be buried at Abydos. After him, all RMCs were located near the capital in the north.

Evidence suggests that Khasekhemwy was originally known as Khasekhem, which means, 'the power appears' with his power base in the south at Hierakonpolis, and that he later changed his name to Khasekhemwy, or 'the two powers appear', potentially to mark his success in reunifying the north and south of Egypt (Friedman 1999: 9-11). This is further supported by the fact that on several occasions his name is written in a cartouche surmounted not just by the falcon god Horus, symbol for the living king, but also by Seth. Seth was a mythical animal who Khasekhemwy's predecessor Peribsen used as his sole emblem of kingship, marking a break with earlier tradition and providing one of the reasons for believing that a period of political turmoil unfolded during the 2nd dynasty (Dodson 1996). In addition to expressing his intention to reconcile the two main territories of Egypt by changing his name and combining the two divinities, Khasekhemwy's name is often introduced with the expression *htp nbwy imyw.f*, which means "the two lords who are in him, are reconciled", further supporting the notion of reconciliation (Alexanian 1999).

Bearing this notion of reconciliation in mind, the following analysis of Khasekhemwy's building projects presented below and discussed in greater detail in Chapter 9 supports the notion that even if there were no political dissent, Khasekhemwy's agenda as a ruler was very much concerned with bridging and reconciling. With regard to his monuments, it is generally understood that Khasekhemwy undertook the building of his first enclosure at his original power base at Hierakonpolis, as Khasekhem, and later, once he gained control over the entire Egyptian territory (roughly from the Mediterranean coast to Aswan in the south), started building his RMC at Abydos, where Egypt's first kings and his immediate predecessor Peribsen were buried. The following analysis suggests that Khasekhemwy may have started building at Abydos when he gained control of that region only and may potentially have returned to it later, once he had gained control of the entire territory. The following analysis begins with Khasekhemwy's tomb and associated enclosure at Abydos before moving on to his other mudbrick enclosure at Hierakonpolis and the limestone one at Saqqara. A chronological interpretation of how these monuments relate to one another is also provided in the concluding remarks of this section and returned to in Chapter 9.

Tomb Location

Khasekhemwy's RMC at Abydos is consistent with the local, royal ED tradition in that it consists of a tomb and a separate enclosure built amongst those of his predecessors, employing principally mudbrick (fig. 2.4, 6.2). As with all the earlier royal tombs at Abydos, the substructure is all that remains of Khasekhemwy's tomb. Still, the remains provide a range of useful information. Like all royal tombs, Khasekhemwy's was built on the west bank of the Nile and, following local royal tradition at Abydos, was placed in the ED royal cemetery in the low-lying desert of the palaeofan of the major local Wadi Qa'ren, 2 km south of his enclosure (see tables 9.1, 9.3). Although part of the ED royal cemetery, Khasekhemwy's tomb is slightly separated from the earlier arrangement of tombs (80 m) where the tomb substructures are usually 5-10 m apart, and is at a point furthest away from that of his immediate predecessor Peribsen's (245 m; fig. 2.4; Dreyer *et al.* 2000: 123). Its orientation follows a N-NW, S-SE axis and aligns perfectly with the wadi and his enclosure further north. The axis of the substructure's main entrance to the south is also directed towards the wadi entrance, while the entrance leading to the storerooms is directed to the north towards the settlement, temple and enclosure area. Both the location and orientation of his tomb highlight the importance of the local Wadi Qa'ren, which is thought to have acted as a monumental natural gateway to the land of the dead (fig. 6.15; Richards 1999; Dreyer 2006: 128; Magli 2011).

Material Orchestration

This section develops further the logistical implications of his building at Abydos. It offers a sequential breakdown of the architectural design of Khasekhemwy's tomb with particular reference to the construction phases to provide a temporal backdrop, in so far as it is possible, to the material consumption and possible inferences that can be drawn with regards to workforce and the organisation of work.

Khasekhemwy's substructure was modified five times. The initial design is very much based on that of his predecessor Peribsen's (fig. 2.16), consisting of a central burial chamber accessed by a ramp to the south and surrounded by storerooms (figs. 6.2, 6.3, 6.5.; Dreyer *et al.* 2003: 101-14). The modifications of his tomb may be broken down as follows.

1) Blocking off of the passage between the north storerooms and the burial apartments to the south, a feature maintained throughout the life of the tomb; storerooms were added both north and south (Dreyer *et al.* 2003).

2) Sinking of the burial chamber, and lining of floor, walls and ceiling with blocks of limestone (figs. 6.6, 6.7.) The idea that the chamber was lined with limestone blocks to offer a flat surface for decoration (Arnold 1991: 164) may be ruled out as this would be more easily achieved with mud-plaster. The blocks provided either temporary protection during the tomb modifications (Dreyer *et al.* 2006: 112), permanent protection in view of the voluminous superstructure, or simply imitated royal tombs in the north.

3) Adding of more storerooms to the north and south (Dreyer *et al.* 2003: 108-11).

4) Starting but not completing a final phase which consisted of a 28 m long southern extension (Dreyer *et al.* 2006: 128).

The modifications increased the structure's size and made it resemble a local Abydos version of the early 2nd dynasty RMCs at Saqqara in layout (figs. 2.11, 2.12; O'Connor 2009: 156).

Khasekhemwy's final tomb design also closely resembles tomb 653 at the private ED cemetery at Helwan in the north, across from Saqqara, in orientation and layout, but is a much larger version (see Saad 1951: 18-21). Although the tomb at Helwan cannot be securely dated, the spatio-temporal patterns of development of the cemetery suggest a late 2nd or early 3rd dynasty date (Jeffreys pers. comm. 2012). While the time elapsed between each modification of Khasekhemwy's tomb cannot be known, the overall work was broken up into smaller, more manageable phases of activity presumably a reflection of the often-attested seasonality of mudbrick manufacture (Ikram 2004: 161; Van Beek 2008: 149). Irregular bonding could also reflect different building stages and/or different groups of masons. Nevertheless, irregular bonding shows poor craftsmanship (Spencer 1979a: 14).

The design modifications reflect a mixture of local Abydos and non-local Saqqara traditions. For instance, the sinking of the burial chamber perfects a long-lasting local tradition of having royal burial chambers as the deepest and largest chamber of the substructure (Engel 2008: 33). The modification of the substructure is another common local feature also visible in four Dynasty 0 royal tombs and those of kings Den and Qa'a (Engel 2008). The modifications to the layout transformed the typical Abydos substructure into a local version of the northern rock-cut galleries of the early 2nd dynasty RMCs at Saqqara, and in particular that of Hetepsekhemwy, the founder of the 2nd dynasty and of the first royal cemetery in the north (fig. 2.12; Dreyer *et al.* 2003: 108; O'Connor 2009: 157). However, these modifications were within the limits of what was available locally in terms of geology, and also, as we will see, were also within the limits of locally available materials and associated workforce.

Nothing remains of Khasekhemwy's superstructure at Abydos, except for a few mudbricks and scattered blocks of limestone. The width of the substructure walls (0.5-8.0 m) reveals the need to support a heavy superstructure to make up for the unsound local geology (Engel 2008: 32-3). The sinking pattern of the central substructure walls suggests that a mound-shaped superstructure 3m high and 35m wide, filled with 6,300 m^3 of desert rubble and lined with mudbrick and blocks of limestone (Dreyer 2003: 108-10) was placed slightly north of the centre of the tomb (Dreyer 2003: 138). The extent to which mudbrick and limestone were employed is unknown. The asymmetry suggests that the weighty superstructure was built before the southernmost chambers were added (4th building phase; Dreyer *et al.* 2003: 108-10) but after the initial design, and was thus likely to be a modification of a smaller and more modest superstructure traditionally built above the BC at Abydos (Dreyer 1991; Engel 2008: 35). Based on a depiction of a royal tomb found on a seal at Abydos, (Reisner 1936: 229-30) the royal superstructures may have been stepped from the time of Anedjib (7th ruler of the 1st dynasty) onwards (Bestock 2008). A private example of this could be the superstructure of tomb 3038 at Saqqara that belonged to a high official during the reign of Anedjib (fig. 6.4). The fact that Khasekhemwy's tomb was later known as the 'Mountain of Khasekhemwy' further supports the existence of a mound or stepped superstructure (O'Connor 2009: 156). Given that Khasekhemwy appears to incorporate features of the

2nd dynasty RMCs at Saqqara into his own RMC, it is possible that the above-mentioned clues regarding the volume and shape of his superstructure may point to the nature of the now missing 2nd dynasty superstructures at Saqqara. Altogether, the evolution in the design of Khasekhemwy's tomb points to an attempt to bring together southern and northern royal funerary traditions, as will be discussed further in Chapter 9.

The main materials used for Khasekhemwy's tomb considered here are mudbrick, wood and limestone (see table 9.5). Grass matting was also used, as was mud and gypsum mortar and plaster, sand and rubble for the infill (material used to fill in a space, cavity or gap). Whitewash was used for finishing the complex. The measurements given in the following tables are estimates extrapolated from preserved remains. Table 6.1 gives the material orchestration in Khasekhemwy's tomb substructure; Table 6.2 provides rough estimates of the volumes of each material consumed; and Table 6.3 estimates of volumes consumed per substructure's building phase.

Architectural Feature	*Material*	*Volume (m^3)*
Walls	Mudbrick + mud mortar	925
Wall Coating	Mud plaster + whitewash	n/a
Ceiling	Wood (acacia or sycamore)	150
Burial Chamber Lining	Limestone	35
Burial Chamber Ceiling	Limestone	30
Burial Chamber Floor	Limestone	30
Superstructure Infill	Rubble	6,900
Superstructure Casing	Mudbrick + limestone blocks	Unknown
Other	Wooden shrine in BC, painted	Unknown

Table 6.1. Material Orchestration in Khasekhemwy's tomb substructure (my calculations from Dreyer *et al.* 1998, 2000, 2003, 2006)

Material	*Volume in m^3*	*Number of Individual Unit* (27 x 12/13 x 7 cm)	*Total Volume (%)*
Mudbrick	925	392,000 bricks	79 %
Wood	150	915 beams	13 %
Limestone	90	n/a uneven blocks	8 %

Table 6.2. Volumes of construction materials used for Khasekhemwy's substructure (my calculations from Dreyer *et al.* 1998, 2000, 2003, 2006)

Building Stage	*Mudbrick m^3*	*Mudbrick Metric Ton*	*Wood m^3*	*Wood Metric Ton*	*Limestone m^3*	*Limestone Metric Ton*
Stage 1. Central Chambers	205	312	150	88.5	n/a	n/a
Stage 2. North & South Storerooms	400	609	380	224	n/a	n/a
Stage 3. Modifications to Burial Chamber	15	23	n/a	n/a	90	235
Stage 4. Extension to North & South Storerooms	305	464	420	248	n/a	n/a
Total	925	1,400	16.5	9,735	90	235

Table 6.3. Estimates of volumes of material consumed per substructure building phase (my calculations from Dreyer *et al.* 1998, 2000, 2003, 2006)

Before even starting to build, it was necessary to excavate a pit for the substructure. It is estimated that a total of 6,500 m^3 of desert gravel was excavated for Khasekhemwy's substructure, much of which was used as later infill. Table 6.4 gives estimates of the volume of gravel and the time taken for each building phase, as a maximum and minimum range.

Building Stage	*Surface Area Built in m^2*	*Area in m^3*	*Pit Area in m^3*	*Days to Excavate with 40 Workmen*	*Months or years to excavate*	*Days to Excavate with 100 Workmen*	*Months or years to excavate*
Stage 1. Central Chambers	210	485	1,370	250	8 months	100	3 months
Stage 2. N & S Storerooms	370	850	2,405	435	14 months	175	6 months
Stage 4. Extension N & S Storerooms	380	875	2,470	450	15 months	180	6 months
Total	990	2,300	6,500	1,135	3 years	455	1 year, 3 months

Table 6.4. Pit excavation time for each building phase (my calculations from Dreyer *et al.* 1998, 2000, 2003, 2006)

The pit, in its totality, could have taken 40 workmen (10 diggers and 30 porters) three years to excavate or 100 workmen just over a year and three months. During each excavation period, the timber for the masonry would have been collected and prepared and, depending on the type of organisation in place for the manufacture of mudbrick, ingredients would have been collected and the bricks manufactured and dried. As the tomb and enclosure are likely to be contemporaneous, the brick production may have been the same as that carried out for the associated enclosure and perimeter wall 2 km north by the cultivation. Production may have been restricted to spring and autumn to avoid cracking of the bricks, as extreme temperatures exacerbate the shrink-swell characteristic of Nile clays. Brick production requires vast amounts of water, so bricks would have been manufactured and dried in or near the edge of the cultivation, where water was accessible, and subsequently brought to the building site where they would have been stored near the tomb. The south entrance and the northeast ramp are likely to have been used for the transport of construction materials (Engel 2008: 33). It is estimated that the mound comprised approx. 3,700 m^3 of material, which consisted essentially of desert rubble obtained from the excavation of the pit.

Mudbrick

Approximately 925m^3 of mudbrick was required for Khasekhemwy's substructure. Unfortunately, no bricks could be tested scientifically for composition because the substructure is now covered with sand. Unpublished photographs give the impression that the bricks are much darker than those of Khasekhemwy's enclosure at Abydos (figs. 6.6, 6.7). This could be the result of the bricks not having been exposed to the whitening effects of weathering, or an indication of a greater use of either (a) fresh and/or palaeo-alluvial sediment, which is generally dark grey brown in colour, and/or (b) charcoal and ash, which is attested in all bricks analysed for Khasekhemwy's structures.

Field topsoil, palaeo-sediments, and sediments from riverbanks or canal dredging are all potential sources of alluvium for the mudbricks used in Khasekhemwy's tomb. Sediments obtained from riverbanks and canal dredging remain the most cost effective sources of alluvium (Fathy 1973: 198), but their use for mudbrick rather than as a fertiliser in the fields could be construed as a form of conspicuous consumption and may also have held deep symbolic significance (Goyon *et al.* 2004: 109-10). Sediments would have been available in greater volumes at Abydos, where the valley is five times wider than at Hierakonpolis (20 km and 4 km respectively). Sediment removal would affect local agricultural production less in the Abydos region and may therefore involve less of a conspicuous agricultural sacrifice than in other regions further south where the valley is narrower, such as at Hierakonpolis. Alternatively, palaeo-alluvial soil could have been accessed through a cut in the desert edge, as at Hierakonpolis (Friedman 2000).

Based on available photographic evidence, it appears that organics, such as straw, chaff or manure, were not used, as these are not visible in the pictures. Still, as organics were used for the mud-plaster of his tomb and in the bricks and mortar of his enclosures at

Abydos and Hierakonpolis, the use of these should not be excluded for his tomb (Friedman 1999; O'Connor and Adams 2000). If so, then it is estimated that approximately 18.5 tons of chaff would have been required for Khasekhemwy's tomb. Chaff is generally collected from mid-February to May, but could be stored and used all year round. Yet, it was mainly used for feeding livestock when grass was unavailable during the inundation (June–September) and the winter months. Therefore, 18.5 tons of chaff represents about 2,055 meals for cattle. Removing such significant volumes from its main economic use as fodder for animals constitutes a significant outlay in itself.

The water used for the mudbricks would have been obtained from a canal running close to the manufacturing site, and water for the mortar and whitewash would have been brought to the construction site.

In terms of construction, it is estimated, according to Engel (2008), that a single mason could lay 1,000 bricks a day, or 1.8 m^3 of mudbrick. Logistically, it would have taken one mason just under a year, or two masons six months, of uninterrupted work to complete the entire substructure. However, as discussed, the building of Khasekhemwy's tomb took place in stages. Table 6.5 shows that volume of mudbrick used for each construction stage and the time it would have taken one and two masons to build each stage.

Building Stage	*Volume of Mudbrick in m^3*	*Days with One Mason*	*Days with Two Masons*
Stage 1 (Central Chambers)	205	114	57
Stage 2 (N & S Storerooms)	400	222	111
Stage 3 (Modifications to Burial Chamber)	15	8	4
Stage 4. (Extensions to N & S Storerooms)	305	169	85
Total	925	513	257

Table 6.5. Estimated volume of mudbrick constituents for each phase (my calculations from Dreyer *et al.* 1998, 2000, 2003, 2006)

The plaster in the burial chambers is described as made from alluvial silt (Engel 2008: 32). The entire substructure was finished with a lime whitewash (fig. 6.5; Dreyer 2003: 108-10).

Limestone

With the exception of Den, the fifth king of the 1st dynasty buried at Abydos, Khasekhemwy is the only other ED ruler for whom the use of stone with mudbrick RMC is attested (fig. 6.6, 6.7). A minimum of 90 m^3, or 235 metric tons of limestone, were used to line the floor, walls and ceiling of his burial chamber, but more was used in some unknown measure to line part of the superstructure. Comparison with later limestone masonry led many to describe the masonry of Khasekhemwy's burial chamber as poor (Petrie 1901: 13; Amélineau 1902: 123). Yet, upon closer inspection and in comparison with earlier practice rather than later, it is clear that the lining of his burial chamber required skill. Limestone's porosity and high calcite content make it easier to extract than other stones (Klemm and Klemm 2008: 56)

The blocks vary in dimension, are mostly only partially dressed and have joints that, although often skewed, are carefully executed with a fine-grained gypsum mortar derived from limestone, which is the best way to cement blocks of limestone together (Petrie 1901: 13; Dreyer 2003: 108-10). While blocks do vary in dimension (as they do for Khasekhemwy's possible enclosure at the Gisr el-Mudir at Saqqara as discussed below), many are similar in size; the two that Amélineau (1902: 123) measured are almost identical (1.08 x 0.50 x 0.18 m and 1.01 x 0.55 x 0.18 m respectively). Although they vary in length and width, the height is constant. The only exception occurs in a number of blocks used to pave the floor, where consistency is less important and what matters is coverage over a flat surface. Maintaining a regular block height is a prerequisite for a wall's cohesiveness. The same height but inconsistent width and length is also visible in the blocks used for the monumental limestone enclosure potentially ascribed to Khasekhemwy at Saqqara. The consist height is a natural feature of the local limestone, which occurs in sheets (see section 6.4 and fig. 6.46; Klemm and Klemm 2008: 17). The blocks were worked with a stone-hammer and often have only half of their faces dressed, as the quarrymen used the stone's natural cleavage lines as much as possible, reducing the amount of work required to shape the block and indicating they had an awareness of the properties of the material. The fully dressed blocks were finished using a flint rather than copper adze. The tool marks indicate that the stone was soft and dragged during dressing, implying the working of freshly quarried stone (Petrie 1901: 13).

The limestone blocks used to line the superstructure (40 cm long) were cut with the same tools used for the burial chamber blocks but show a different dressing method (Dreyer 2003: 108-10). The limestone blocks found near the superstructure exhibit two cutting marks, indicating that large-scale stone quarrying operations were already implemented and were well organised, as they were later. The same remains of mortar as those found on the blocks lining the burial chamber were also found with the surface blocks, showing an overall consistency in work that was probably carried out by the same team (Dreyer 2003: 108-10).

The limestone was not tested for provenance, so its source remains unknown. Yet, several ancient limestone quarries that are either undated, or of a later date, are attested locally, in the wider region and in the north of Egypt, and may all be considered potential sources (Aston *et al.* 2000: 8, 13; Klemm and Klemm 2008). The closest is an undated quarry 2 km north at el-Madfuna, and two Middle Kingdom-Roman Period quarries are 5 km away, near the modern villages of el-Salmuni and Wadi Naqb el-Salmuni (figs. 6.8, 6.9.). More distant OK quarries exist between Saqqara and Abydos (75-190 km), all of which would have required upstream transportation (Arnold 1991: 29; Aston et. al 2000; Klemm and Klemm 2008). The only known limestone quarries securely dated to the ED are the ones that supplied material for the limestone enclosure built at Saqqara 450 km downstream (see fig. 6.10 and section 6.3). Although distant and upstream, this source should not be ruled out, as the limestone it produces is available in sheets about 0.30 m thick, which is comparable to the blocks used at Abydos. Additionally, Saqqara is likely where the permanent limestone workforce, was based, judging by the use of limestone in funerary architecture at Helwan and Saqqara. The limestone came either from (a) local limestone outcrops and was cut in similar ways to the blocks used for the Gisr el-Mudir at Saqqara, (b) sheets of local limestone the source of which remains to be located, or (c) limestone extracted from Saqqara and brought to Abydos with or without its workforce. The use of limestone at Abydos could point to a moving, limestone workforce. If the material is not sourced from Saqqara then the systematic thickness might point to a Saqqara based workforce that replicated the measurements they were accustomed to and applied to for locally quarried limestone. Alternatively, bringing limestone 450 km upstream along with the stone cutting specialist workforce is an obvious display of conspicuous consumption that would fit with the designs of a grand builder such as Khasekhemwy. The limestone may also have been a way to incorporate material from the 2nd dynasty royal necropolis into his tomb, a concern already expressed in its design and layout. Wherever the quarry was, the two key points are (a) that the limestone quarry is likely to have been further away from the construction site than any of those used for the later RMCs that were predominantly of limestone, (b) that any source located north of the tomb site would have involved transporting the stone upstream and (c) that there are interesting parallels with the use of limestone at Saqqara which may point to a moving workforce. In other words, the choice of site location was not yet driven by the priorities of stone building, but rather by those of local mudbrick building practices.

Wood

Finally, one last material needs to be considered when discussing Khasekhemwy's tomb and this is wood. Except for the ceiling of the burial chamber, which was roofed with limestone blocks, the majority of the substructure was roofed with wood beams (fig. 6.11). The beams are single trunks (0.15 x 2.00-3.00 m); a few significantly longer ones (4.5-5.5 m) were used exclusively to roof the central room above the burial chamber (Tables 6.2 and 6.3). In total, approximately 950 trunks were used. The type of wood remains undetermined, but based on the small diameter of the beams, a local indigenous wood, such as sycamore or acacia, seems most likely (Dreyer 2003: 112). Unlike other royal tombs at Abydos, the walls of tomb were not lined with wood panelling. Traces of red pigment were found on inclined boards, indicating that a large wooden shrine measuring 2,65 x 4,70 m and up to 1,5 m in height was set up in the burial chamber (Dreyer 2003: 108). In keeping with tradition, Khasekhemwy had an associated enclosure built 2 km north of his tomb, right by the edge of the modern cultivation and it is to this structure that the discussion now turns.

Associated Enclosure

Khasekhemwy's enclosure at Abydos, known as the Shunet el-Zebib, was the last of its kind to be built amongst the remains of those of his predecessors and is the only one still standing, something returned to in Chapter 9 (figs. 6.1, 6.12, 6.13; Bestock 2008: 49). Although the exact function of these enclosures remains unclear, their association with the royal tombs 2 km to the south, their immediate proximity to the local temple and settlement, as well as the palace-like character of their decoration, suggests that they were sacred places designed for rituals of kingship, both for the living (Friedman 2007; McNamara 2008) and dead king (Kemp 1966; O'Connor 2009: 168-9). They may have acted to some extent as early versions of the later valley-temples associated with pyramid tombs (see Chapters 7 and 8; Stadelmann 1985: 295-306).

Associated Enclosure Location

Khasekhemwy's enclosure is 2 km north of the royal tombs, in the low-lying desert, right behind the ED temple and settlement area, amongst the foundations of the earlier enclosures (fig. 6.12; 6.14). In physical terms, this was a savannah-like, liminal setting, where the wadi fan and desert meet the cultivation, and hence the enclosures where well placed to be associated with kingly ritual of life and death. As is the case with his tomb, Khasekhemwy's enclosure is the most south-westernmost of all the ED enclosures at the site. Unlike his tomb however, the enclosure sits within the larger group of ED enclosures and also immediately south of his predecessor Peribsen's (with less than 1 m separating them in places), and 35 m west of an enclosure of unknown owner (fig. 6.12; the 'Western Mastaba'). The fact that these enclosures were deliberately dismantled but not completely removed from the landscape explains the patterns of proximity but lack of overlap. Immediately west are 14 buried boats of an earlier date, probably 1st dynasty, that point to Khasekhemwy's enclosure in a north south row (figs. 6.16, 6.17, 6.18; O'Connor 1991, 1995; Ward 2006). As with all the other enclosures at Abydos, the longer sides of Khasekhemwy's enclosure face the desert and cultivation respectively, and the four corners point towards the four cardinal directions. This means the shorter side is exposed to the dominant winds from the north, thus minimising aeolian and sand erosion, making the enclosures appear more monumental from the valley and settlement area.

Associated Enclosure Material Orchestration

Khasekhemwy's enclosure is the largest of all such buildings, measuring 65 x 127 m with walls 5 m and 11 m high, and is surrounded by a perimeter wall, which is unique at Abydos but also the case with his Hierakonpolis enclosure, as we shall see later in this chapter (fig. 6.12; see section 6.3). As for Aha and Djer's enclosures (the 2nd and 3rd kings of the 1st dynasty), and that of Khasekhemwy's immediate predecessor, Peribsen, a cult building is located in the southeast quadrant of which only the foundations remain (figs. 6.12, 6.20.). While the cult buildings inside the enclosures of the 1st dynasty kings appear perfectly aligned with the rest of the enclosure, Khasekhemwy's and Peribsen's both fit imperfectly with the surrounding enclosure (fig. 6.12), a point of interest to which discussion will return with respect to varying mudbrick compositions (see section below and Chapter 9). In keeping with previous ED enclosures and decorated mastabas, the eastern wall of the enclosure is decorated more intricately than the other three walls, with deeper niches, supporting the importance of visibility from the cultivation and settlement area (fig. 6.19; Adams and O'Connor 2003: 84). As in previous structures, Khasekhemwy had an entrance in the southeast part of the structure, but unlike those of the 1st dynasty, the main entrance for his and for Peribsen's was near the northern corner, in the northwest wall (fig. 6.12; O'Connor 1989).

Unlike his tomb, Khasekhemwy's enclosure does not show obvious, multiple construction phases. Two different construction methods were nonetheless employed that show a good awareness of construction (Power 2000: 5). The inner core, which represents the bulk of the masonry, was built by stacking bricks transversely with their header ends forming the faces, creating vertical lines of weakness inside the walls. At times weakness was further exacerbated by the limited use of mortar, thus reducing the cohesiveness of the masonry. However, such structural features also mean that the masonry could move laterally during earthquakes, thus protecting the structure.

The bricks were laid to overlap, increasing the transversal bonding of the core and making the wall resistant to vertical cracking, one of the major problems with such massive mudbrick constructions (Power 2000: 4). To further enhance bonding, grass matting was laid systematically every ten courses in the lower sections and every seven courses in the upper section. This strengthened the structure by reinforcing the weak joints and helped the masonry to dry faster (Crosby pers. comm. 2009). In some rare cases, bricks were laid diagonally to bond the stacks and to level courses. The walls' outer shells are only about two courses thick and made of alternating courses of headers and stretchers (Power 2000: 3). The outer masonry is poorly bonded to the inner core, with only a few sporadic bonding bricks observed. The mortar used for the outer masonry is more adhesive than that used for the core, which may have been an attempt to make up for the outer masonry's weakness. However, the more adhesive mortar was not used regularly (Power 2000: 4). The four corners are well bonded with the headers and stretchers laid out in a radial pattern to prevent the corners from separating and collapsing (Power 2000: 5). Overall the inner core shows a high degree of expertise.

The main materials for Khasekhemwy's enclosure are mudbricks, mud-mortar and grass mats, and the walls were finished with a layer of mud-plaster, a poor quality coat of gypsum, or lime plaster and whitewashed (fig. O'Connor 1989; Power 2000: 2; Bestock 2008: 57). Drops of red paint at the foot of the enclosure's external walls suggest that a red band was painted around the structure, similar to that visible in his predecessor's Peribsen's enclosure and the Western Enclosure (fig. 6.21; Adams pers. com. 2010).

Mudbrick

Four distinct groups of mudbricks were used in Khasekhemwy's enclosure at Abydos (fig. 6.22.a, 6.22.b, 22c). The bricks of the enclosure and surrounding perimeter wall follow a single high quality recipe, the consistency and scale of production indicate knowledge at the level of manufacture as well as that visible in the construction, as demonstrated above. Conversely, the bricks of the cult building vary greatly revealing three macroscopically distinct recipes. Because only the foundations remain, sampling by the author for grain size was limited to one brick per group. Therefore insights into the manufacture and building of this structure are limited compared to the rest of the enclosure, but are still useful (please refer to Chapter 5 for the sampling strategy). The difference in brick composition, quality and distribution points to two distinct strategies regarding the manufacture and procurement of the bricks, which has implications for the construction and potential phasing.

The bricks of Khasekhemwy's enclosure and perimeter wall are dark to very dark grayish brown (10YR 4/2 - 7.5 YR 3/1; see figs. 6.23.a, 6.23.b) and have a silty loam texture, containing on average 9 % clay, 68 % silt and 23 % sand. The majority of the bricks tested (72 %) form an obvious cluster and have high silt content of 73 % on average. The sand grains are well sorted and dominated by fine quartz sand, indicating a preferred fine-grain texture high in silt and low in clay and sand content (fig. 6.22.c, 6.23). As will be discussed in greater detail further in this chapter, low clay content was and still is preferable in Egypt because the high smectite clay of the Nile Valley alluvium expands with water and shrinks with evaporation. These properties cause bricks to crack if not properly tempered (Power 2000).

The macro- and microscopic analyses are consistent and show that the same basic ingredients were used in all bricks. Large quantities of finely chopped chaff were added as temper, along with other organic components (probably manure; O'Connor and Adams 2005), smaller quantities of pottery (mostly gray-, but in two instances, red-coloured) and charcoal, which is visible at a macroscopic level and includes charred bones/insects (as visible in samples AB.K.PW.S.3, AB.K.PW.S.4, AB.H.S.2, AB.K.N.1). At the microscopic level, pottery and charcoal tend to dominate the coarse to medium sand-size grades, with occasional bone and unidentified green translucent rocks and green faience-like material (samples AB.K.S.1, AB.K.PW.S.3), confirming the use of both midden and production (possibly faience) waste. The coarser to medium grades represent only about 5-10 % of the sands.

The finer sand-size grains are dominant (90-95 %), of which the majority is composed of quartz. Desert varnish is present on all grains and about 50 % had facets, which suggests later aeolian deposition, typical of desert environments. Concretions are found at the coarser grades of two bricks (samples AB.K.S.1 and AB.K.W.1). A positive relationship between sand, silt and clay would be expected if all the grain sizes came from the same source. Only the sands and silts however, show a positive relationship, and it is likely that these two components were added together from the same source (figs. 6.24, 6.265, 6.26). The high silt content, dominance of fine grains and absence of polished and well-rounded grains suggests that the brick-makers targeted silty sediments with well-sorted sands acquired mostly from aeolian deposition, which would be typical of a low energy environment such as the ponding backwaters far from the river or an equally distant canal close to the edge of the desert. Such a location would make sense, and could potentially have been close to the construction site.

The recipe shows a preference for low amounts of clay, indicating careful control of the paste's stickiness. The low clay content was made up for by adding organics in the form of ash and most likely manure to increase the stickiness of the paste, and with the ash acting as a sort of cement (Jackson *et al.* 2010). The recipe also shows a preference for fine grains, which makes the brick stronger by raising the number of grains and thereby increasing the internal surface friction. The very coarse inclusions may show a desire to manufacture rapidly. The ingredients and sorting show specialist understanding of the materials' properties in terms of how to combine materials in the best proportion and how to get the right texture in terms of sorting to produce a quality brick. Even so, a variety of textures were tolerated for the pastes, but this would be expected in such large-scale mudbrick production. The majority of the outliers fall within the silty loam category, and tend to differentiate themselves by being sandier, with a higher clay content and/or poor sorting (fig. 6.23).

Statistically, the clays also have a low coefficient of variation of 2.3 contra, 7.1 for the silts, confirming the narrow range of variation visible in the ternary graph. The lower variability suggests that the clays were under some sort of control (Eerkens 2000; Eerkens and Bettinger 2001). Traditionally the control of clays is achieved by tempering the paste with coarser aggregates, such as chaff or sand. The negative relationship of the clays with both the silts and sands suggests that the clays were not associated with the silts and sands, but instead they came from a separate source. This separate addition would be achieved in two ways. If the main sediment was low in clay, additional clay could be added from a separate source. Alternatively, if the sediment was clay rich, which is likely given the low energy environment hinted at by the fine nature of the coarser grains (sands and silts), clays could be removed from the main sediment through levigation. As the main binding agent, clay is a key component in the brick-making process. Questions of clays are even more relevant in Egypt owing to the presence of high smectite clays. Controlling the clay makes the material more stable by reducing the chance of the bricks cracking during curing or swelling when exposed to moisture. The evidence suggests that the control of clays may have also been achieved by controlling the initial amount rather than adding coarse aggregates, such as sands, which, given their dependence on the silt, appear to have come with the silty sediment. Clay control adds another stage in the manufacture of mudbricks and shows a degree of expertise. Clay control is dependent on the interpretation of the relationship of the three main grains size groups and the degree of variation visible for the clay content.

The outlying bricks show a good quality manufacture. AB.K.W2 and AB.K.W1 both have a sandy texture with poor sorting and a high clay content. The first has a dominant fine fraction formed by the penultimate fine grade (0.121 mm) rather than the smallest as in the case of the other bricks sampled. It also has a subordinate coarse fraction composed of ceramics and charcoal. The sorting suggests that the high clay content may have been tempered with midden waste. The second brick has a dominant finest grade and subordinate medium fraction formed of 50 % concretions, indicating that the texture resulted from the use of poorly sorted coarse sediment that contained concretion. AB.K.PW4 is sandier, but unlike the previous bricks, it has a normal clay content and a good sand sorting with a dominant finest grade composed of quartz with desert varnish, pointing to the use of a sediment that is more poorly sorted than for the majority of the bricks, but still better than the above batches. AB.K.N1 is the most striking outlier. This brick belongs to a batch presenting the highest sand and clay content, making it much stickier and grittier than the preferred silty paste. AB.K.N1 has a moderate to poor sorting dominated by the fine grain fractions and with a subordinate coarse grain faction. However, the dominant fine grain fraction is not the smallest grade (0.063 mm), as with the majority of standard and outlying bricks, but the 0.125 mm one. The fact that the brick's composition is very close to the actual published loam sample (O'Conner 2005) may be an indication of the lack of processing of the batch to which this brick belongs. The brick has the same microartefacts content as the silty bricks. Despite departing from the ideal recipe with high clay contents or poor sorting, all the outlying batches still made good bricks.

Group 1

From the visual observation of the surface remains, it is possible to identify a dominant group of bricks from the cult building that are dark grayish brown (10 YR 4/2) and a little lighter than the enclosure and perimeter wall bricks (fig. 6.27). One sample was taken of this group (AB.K.CB.S.3) and it has the texture of a silty loam verging on that of a loam with 15.5 % clay, 51 % silt and 33 % sand (fig. 6.22c). The sands are well sorted with dominant fine grains that consist primarily of quartz showing desert varnish with traces of charcoal, including charred bone. Black ceramic dominates the coarser grades. The bricks have a high chaff content. The colour and sorting and overall recipe are similar to that of the enclosure bricks; however the source of the midden waste is different and the texture is closer to AB.K.N1 and to the published sample of local alluvial loam (O'Connor and Adams 2005).

Group 2

The second most common visually identified group of bricks used for the cult building contrast with the majority in that they are yellowish brown in colour. Again, it was only possible to take one sample of this group (AB.K.CB.S.2): it is also a silty loam very close in texture to a loam, and is formed of 8 % clay, 50 % silt and 42 % sand. The sands are particularly well sorted with over 70 % that are of the finest grade and composed essentially of quartz showing desert varnish with subordinate unworked limestone, fine gray ceramics, polished and calcinated bones. Given the yellowish colouration of the bricks, the use of a sediment formed from decayed limestone is indicated. The polished bones indicate that they were worked by water and potentially introduced with the sediment(s) used. The fine gray ceramics and calcinated bones come from midden and/or hearth waste. The bricks also have a high organic content.

The recipe is similar to that of the previous group but employs different ingredients in terms of the sediment and midden waste.

Group 3

A third group of bricks from the cult building is the most unusual and consists of very dark gray (7.5 YR 3/1) bricks that are very sandy, fast deteriorating and poor in quality. The single analysed sample (AB.K.CB.S.1) has the texture of a loam verging on that of a sandy loam and contains 11 % clay, 41 % silt and 48 % sand. The sands are poorly to very poorly sorted. Although they have a fine grain dominance, the grains are almost normally distributed across the four finest grades with a peak in the two penultimate finer ones. Concretions and fine gray ceramics with traces of black sedimentary rocks dominate the coarse fractions and quartz with desert varnish and traces of charcoal, including charred bone, dominate the finer grades. Given the regular use of ash, the colour seems to come from the sediment used and potentially the black sedimentary rocks. The bricks also contain chaff. Despite high clay content, use of ash and organics, the poor quality of the bricks may be due to the poor sorting. The fact that these bricks are in the minority indicates an awareness of their poor quality and a deliberate avoidance. Or the bricks have deteriorated to such a point that they only appear to have been infrequently used.

It is difficult to draw conclusions about these groups based on a single sample from each structure. Still, based on macroscopic observation of many bricks in the structure, it is possible to suggest that the dark grayish brown and yellowish brown bricks (groups 1 and 2) are of a significantly better quality than very dark gray ones (group 3). The fact that the range between the two sample bricks of groups 1 and 2 is the same as that seen with the enclosure's silty bricks (fig. 22c) suggests that the bricks may come from two groups that are similar in texture showing some continuity in practice despite different sources of ingredients. Both groups 1 and 2 have similar sorting, quartz sand type and content and temper, but different colour sediments and types of midden waste. This suggests similar recipes for texture, but the use of ingredients from different sources; the sediments could come from different sources in the landscape or simply different horizons of a single source. It could be argued that group 1 and 2 bricks have a potentially slightly higher clay content and sandier texture than the enclosure and perimeter wall bricks, but altogether follow a similar recipe, potentially showing a local preference. AB.K.CB1 is part of a very poor quality batch that somehow looks the part in terms of colour, but not in texture. The colour and microscopy indicate that the ash and organic content along with the higher than average clay content are not enough to make a good brick, highlighting the importance of considering both grain size distribution and sand sorting when attempting to assess the quality of mudbrick recipes.

The bricks used for the cult building of Khasekhemwy's enclosure at Abydos are far from exhibiting the homogeneity and consistent, high quality standards of those employed for the enclosure and perimeter wall. While the bricks from group 1 and 2 are potentially comparable to those of the enclosure and perimeter walls, further analysis is necessary. The use of group 1 and 2 bricks with the very poor quality bricks undermines the integrity of the structure; bricks with different recipes behave differently to weathering and other external influences. This points to variable levels of skill and knowledge of mudbrick manufacture on the one hand, and potential input from different manufacturers on the other. Thus an entirely different strategy was likely employed for the cult building than the enclosure wall. The mudbricks used for the cult building also represent a much smaller volume of bricks that are more variable in colour, texture and inclusions, compared to the single recipe of the enclosure and perimeter wall. Although it is difficult to determine textural groups based on a single sample, both macroscopic and compositional analysis point to three different recipes, with potentially three independent sources of manufacture, two exhibiting knowledge comparable to that of the enclosure and one exhibiting a very poor recipe.

Structurally speaking, variability is not advisable in masonry, as it undermines the structure's integrity. Despite the small sample size, the results of the textural analysis indicate that there existed multiple recipes, with two of these producing high quality bricks and one producing poor quality bricks. The indication is that different sources of material were used and also that varying degrees of expertise existed. This is suggestive of either different phases in construction, and/or that different local brick producers were likely taxed a certain percentage of their own production. This means the cult building brick makers oversaw all stages of manufacture from acquisition of raw materials to manufacture and delivery at the building site. Unlike the enclosure and perimeter wall, the central authority did not oversee all stages from brick manufacture to construction. Though this cannot be proven, the reduced size of the cult building compared to the enclosure suggests cult building brick makers may even have been responsible for the enclosure's construction. Access to raw material was down to the producer, not the king and his managerial staff. As we are about to see, the composition of the cult building bricks resembles that of the Hierakonpolis bricks in sandiness and heterogeneity.

It is interesting to return to an earlier architectural observation to the effect that, while Khasekhemwy's enclosure and perimeter wall are perfectly aligned in a way that responds to the natural and cultural local topography, the cult building is not, despite its proximity to the enclosure's south wall. Proximity would have guided the alignment of the cult building if it were built after the enclosure. This distinction is also observed in the case of Peribsen's enclosure and cult building (fig. 6.12). In several ways, the cult building shows less control and expertise in a way that suggests that the specialists called upon for the enclosure were absent in construction of the cult building. It might have been the case that the specialists left the site, leaving a non-specialist local workforce in charge of the cult building. Given the small volume of mudbricks required for the cult building and the easily avoidable misalignment, this seems unlikely. Instead, Khasekhemwy may have incorporated an earlier structure within the sacred space of his enclosure. Earlier structures, such as the fourteen ED boats and two enclosures immediately east of his and the other ED enclosures north and northeast of his, are known from this area. The heterogeneous nature of the mudbricks used for the cult building and its misalignment with the surrounding enclosure suggest that it may be earlier in date than the enclosure, and integrated into Khasekhemwy's later monument. The implications of these findings will be returned to later in Chapter 9. For now let us turn to Khasekhemwy's secondary enclosure at Hierakonpolis.

6.3. Hierakonpolis

Early in his reign, Khasekhemwy also started a mudbrick enclosure (known today as 'the Fort') at Hierakonpolis, probably his original power base, some 150 km south of Abydos (figs. 6.28, 6.29). The monument was built in two distinct phases. While his ownership of the monument's earliest building phase cannot be confirmed, the view is that Khasekhemwy was most likely responsible. Yet, the possibility that a predecessor started the enclosure should not be excluded. Although the presence of an L-shaped structure at Saqqara (Mathieson and Tavares 1993: 27-8; Mathieson 2000: 36) has led some to suggest that early mudbrick enclosures may have been built in northern Egypt

(Van Wetering 2004), this remains to be proven. Thus, the Hierakonpolis enclosure remains the only other enclosure known with certainty outside of Abydos, and represents the southernmost occurrence of this structure type (Friedman 2007: 309). No tomb has been successfully associated with it. As such it is thought that the structure has more to do with rituals pertaining to the living king, such as coronation or *Heb-Sed* rituals, than to funerary rituals associated with the dead king, as proposed for the Abydos enclosures (Friedman 2009; O'Connor 1989, 2010). Association with a living king seems supported by the fact that all activity ceased within the enclosure around the middle of Khasekhemwy's reign, to judge from the pottery evidence (Friedman 2008: 309). Similar rites should not be excluded for Abydos, especially since rituals of the living king, such as the *Heb-Sed*, were carried out in later royal funerary contexts, such as Djoser's RMC at Saqqara, where the enclosure still plays an important architectural role.

Location

As at Abydos, the Hierakonpolis enclosure is built on the Wadi Sufian palaeofan, slightly north of the main wadi channel, right at the edge of the cultivation (figs. 6.28). The nearest major settlement was most likely Nekhen, situated across the river or perhaps even on an island, where a shrine dedicated to the local falcon god Horus stood (Bunbury and Graham 2008: 243; McNamara 2008). The enclosure, which now sits alone, was built over a Predynastic cemetery (Adams 1987), 250 m north of a Predynastic settlement with a ceremonial centre (HK29). The settlement dates to Naqada II-IIIa and shows evidence of what may be the remains of monumental architectural structures initially built with perishables and later rebuilt with mudbrick (Hoffman 1989; Friedman 1996; Hikade 2008, 2011). Further up the wadi is the elite Predynastic cemetery HK6 (Naqada I-III), which also shows unique wooden architectural features, including pillared halls (Friedman 2009: 4-7). Therefore, although potentially standing alone, the Hierakonpolis enclosure was very much imbedded in an earlier cultic landscape. As at Abydos, its four corners point to the four cardinal directions. Though the enclosure is almost square, the longer sides face the desert and valley respectively. Unlike that at Abydos, the enclosure has only one entrance, which, in keeping with earlier enclosures at Abydos, is to the southeast. This makes sense considering the local topography. Interestingly, in a similar fashion to Abydos, it is possible to draw a straight line connecting the settlement area, Nekhen, the enclosure and the narrow gorge of the wadi and the Predynastic cemetery. Whether this was intentional is unclear, but its does highlight connections between settlement and temple, enclosure, local elite cemetery and western wadi (see tables 9.1, 9.3).

Enclosure Wall	*Abydos*	*Hierak. Phase A*	*Hierak. Phase B*	*Gisr el-Mudir*
Orientation	Corners to cardinal points	Corners to cardinal points	Corners to cardinal points	Faces to cardinal points
Dimensions (m)	65 X 127	54.3 X 63.3	57 X 65	360 X 600
Wall Height (m)	11.0	2 - 2.5	9.0	5; 7 with 2 m plinth E wall
Wall Thickness (m)	5.3	2.1	+ 1.5 m outer wall + 1.2 m inner wall = 2.7 m added = 4.7 m final wall width	15.0 - 17.0
Surface Area (m^2)	8,200	3,375	3,819	216,000
Entrances	4	2	1	n/a
Perimeter Wall Dimension	77 X 137	n/a	74 X 74	n/a
Perim. Wall Width	3	n/a	2.5	n/a
Perim. Wall Height	6 - 12	n/a	6-12	n/a
Perim. Wall Surface Area (m^2)	10,550	n/a	5,475	n/a

Table. 6.6. Architectural design of Khasekhemwy's three enclosures (from Dreyer *et al.* 1998, 2000, 2003, 2006, Friedman 1999, 2005, 2007 and Mathieson 2000, Mathieson *et al.* 1997, 1999)

Material Orchestration

The Abydos and Hierakonpolis enclosures share similarities in architectural design and construction materials (Table 6.6). Yet, the most striking difference between the enclosures is the aforementioned, almost square-plan of the Hierakonpolis enclosure. Its surface area is slightly smaller than its Abydos counterpart (65 x 57 m), but the final wall height (11 m) and thickness (5 m) are the same; as mentioned, the longer sides face the valley. The Hierakonpolis enclosure is also surrounded by a perimeter wall and had a cult building inside of which only the foundations remain (Friedman 2007: 310).

However, unlike the Abydos enclosure, the Hierakonpolis structure was built in two distinct stages (fig. 6.30). Judging by the reduced height (2.0-2.5 m), thickness (2.60 m) and lack of plaster, it appears that the first phase was never completed. The second phase consists mainly of an aggrandisement of the original design to make it resemble Khasekhemwy's enclosure at Abydos. It was brought to its final dimensions by adding 1.5 m of masonry, or 5.5 courses, to the exterior and 1.2 m, or 4.5 rows, to the interior. The east wall received an additional course either side to make it thicker. The second outer shell at Hierakonpolis, unlike the veneer of the Abydos enclosure to which it might be compared, was never bonded to the inner core, undermining the stability of the structure (Friedman 2007: 313-4). The perimeter wall was then built and its external faces decorated with pilasters and whitewashed; red ochre paint was used for the lower sections (fig. 6.31). The basal course was laid on a 10 cm layer of sand which itself rested on compacted silts about 15 cm thick (Friedman 2007: 316). The bonding for both phases consisted of a transversely laid core and, in this case, a single course veneer, as at Abydos. Grass matting was employed for the 2nd phase at least, although, unlike at Abydos, it was laid at irregular intervals (fig. 6.32). The second phase corners are better than the first-phase ones, but poorer than those of Khasekhemwy's enclosure at Abydos. Visual observation of the masonry of the 2nd construction phase's southwest corner determined that the corners were formed by having only headers meet, creating vertical lines of weakness consisting of large gaps often filled with substantial amounts of mortar. This indicates that for the second phase, rather than starting with the corners, two or four gangs of workers first built the walls from the centre outwards, eventually meeting at the corners. This technique is very different from that seen for the Abydos enclosure. The enclosure walls have an initial layer of mud-plaster, or primer, with a high organic content, that may be manure, to make the first coat protective; this initial layer was followed by a smooth layer of plaster to receive the final coat of whitewash.

While there is no evidence for the use of stone in Khasekhemwy's enclosure at Abydos, there is evidence for the use of pink granite for finer architectural details, such as lintels and column bases, in the chapel and possibly other parts of the enclosure area, such as the entrance. While the length of time elapsed between the two phases is unknown, the respect shown to the original plan during the second phase, the similarities in execution and the abandonment of the enclosure in the middle of Khasekhemwy's reign, points to a relatively short overall time-span (see table 9.5; Friedman 1999: 9).

Mudbrick

As at Abydos, the mudbricks of Khasekhemwy's enclosure and perimeter wall at Hierakonpolis were tested for composition for comparison with his enclosure at Abydos (see Chapter 5 for general overview of method and Appendix B for detailed protocol). The results of both construction phases are interesting. Overall, while the mudbricks of both phases are sandier than the Abydos main recipe, two distinct recipes are still observable, one for each phase, with the second phase recipe sharing features with the Abydos one (Friedman 1999).

The first-phase bricks show significant variation in both colour and texture, compared to the bricks of the second phase or to those of the Abydos enclosure (figs. 6.33, 6.22c). The majority are brown; however the colour spectrum is wide and also includes dark brown, dark yellowish brown, dark grayish brown and in a few rare instances very dark grayish brown. They have a sandy loam, loam texture, containing on average 12% clay, 42% silt and 46% sand. However, a few finer grained textures in the silty loam and clay loam categories are also present. The clay content ranges more widely than those of the second phase, or those of the Abydos enclosure. An interesting feature is that all the first phase bricks exhibit layers, and occasionally lumps, of different coloured sediments (fig. 6.34.). The interpretation of the layering is problematic, but indicates the use of different coloured sediments in order to gain the adequate texture, but poor mixing.

The majority of the sands are well sorted, with a few moderately sorted, and all have dominant fine grains. Concretions and ceramics dominate the coarser grades often with traces of charcoal, including charred bones and/or burnt sediment. Quartz showing desert varnish, polish and/or patina, dominates the fine grades. Traces of limestone and/or flint are found in half the bricks across all grades and occasionally, traces of ceramic beads, bone, schist, white and black shells, unidentified rocks and in one instance a black shiny charred resin-like material are also present, but rare. Chaff, insect bore holes and chaff impressions are also observed, but in lesser quantities than at Abydos or than observation the second-phase bricks.

It is significant that no recipe groupings could be determined, unlike at Abydos. All bricks show a high degree of variability. However, ceramics and charcoal are present in greater volumes across the lower sand grades, indicating a stronger reliance on midden and hearth waste than at Abydos. The pieces of charcoal observed in the bricks are also much smaller than at Abydos. The bead, flint and schist, indicate that some of the midden waste came from activity areas. The presence of burnt sediment and charred chaff, and occasionally charred pottery, seeds, and small bones, potentially indicates the use of domestic hearth waste and/or material from field burnings (Morgenstein 2007: 113). Further sampling may reveal clearer groupings. Regardless, the variability observed in the colour, grain size distribution and clay content strongly suggests that the lack of grouping reflects less production control.

The dominance of sand with desert varnish suggests aeolian deposition, which is expected in a desert environment. The polished quartz indicates that one of the sediments used was affected at some point by running water and/or wave movement and buried rapidly afterwards, indicating that one of the sediments used, a sandy silt, was once under the influence of a high energy environment and will have contributed to the bricks' sandy texture. The moderate to good sorting with fine grade dominance and the use of ash show a similar strategy in brick-making to Abydos, where production was designed to make strong bricks with less refined material. Such strategies, though by no means ubiquitous, are to be expected along the entire Nile Valley as a means to produce strong bricks given the necessity for high temper/low clay content the high smectite alluvial clays require.

In contrast to the first phase bricks, the second phase ones appear much more homogenous, with a recipe that is much closer to that of Abydos, but in a way that retains features of the first phase bricks (figs. 6.33, 6.35). The bricks are mostly dark brown to dark grayish brown and fall within the range of a silty loam and loam, containing in average 13% clay, 48% silt and 39% sand. Texturally, they fall in between the sandy bricks of the earlier phase and the very silty ones at Abydos. As at Abydos, the bricks have a higher content of chaff and large inclusions of coarse pottery, but also stone fragments, such as limestone chippings. The bricks present either almost indistinguishable layers of pale yellowish brown sediment and/or small lumps of a very hard and dark grayish brown sediment in a way that is reminiscent of the first-phase bricks at Hierakonpolis.

As at Abydos, the sands are well sorted with dominant fine grades. However, the second to last finest grade is either superior or equal to the finest, showing a slightly different sorting than the phase A bricks and the Abydos ones. Concretions, ceramic and burnt sediment dominate the sand grains. Smaller quantities of limestone, charcoal and quartz are also found. Polished quartz with subordinate charcoal at times includes charred chaff, seed, bone and/or ceramic, dominate the finer grades. Green copper oxide, sandstone and other unidentified stones are also occasionally present but remain rare. The clay also has a negative relationship to sand and silt and varies less than the first phase, indicating better control of the material.

The sediments used had inclusions of limestone, concretions and polished quartz, which points to three potential types of sediments. Limestone is present in the immediate environment of Hierakonpolis and an outcrop was worked 100 m west of the enclosure. A mixing pit located about 100 m east of the enclosure was cut through the desert surface (figs. 6.36, 6.37, 6.38) to a depth of 5 m below ground level. The sediment consists of alternating layers of sandy and clayey palaeo-silts. The layers indicate alternating depositional episodes of overbank deposits with varying velocity (strong and weak currents). Broken pottery from the Predynastic period was found crushed at the bottom and matches that used in the second phase bricks and mortar (Friedman 2000: 20-1). This indicates that the pit was used for mixing the second-phase brick paste and may also have been used as a source of alluvium. The distance from the pit to the enclosure strongly suggests that it was not used as a mortar pit, as these tend to be immediately adjacent to the structure for logistical reasons. Approximately 4,000 m^3 of sediment was removed, corresponding approximately to the volume of sediment required for the second-phase enclosure, excluding the perimeter wall, which was also built at the time. The silty pit may have provided the sediment containing polished quartz visible in the bricks. Although it is unclear whether the pit was also used for the first phase bricks (Friedman 2000: 21), similar quarries for the paleo-silts should not be excluded for the earlier phase. The second-phase bricks show very clearly that a darker alluvial sediment was added, possibly from canal dredging or directly from the fields. Another silty deposit with a high concentration of concretions south of the main wadi course was heavily quarried away, providing much of the material potentially for both phases (Bunbury pers. comm. 2008). It would be interesting to increase the sample size to see if the distribution of the bricks in the enclosure would reflect different manufacturing pits.

The mudbricks of the first and second phases differ in recipes. The first phase bricks are sandier and more heterogeneous in colour, grain size distribution, and both clay and microartefact content. The second phase bricks are siltier and more homogenous in colour, texture, clay and microartefact content; they also present more organics as well as large inclusions. The use of ash and well-sorted, fine sands suggests the brick makers overall knew how to produce strong bricks; yet the sandy texture, the lower chaff content, heavy reliance on charcoal and midden waste from both domestic and activity areas give the bricks a domestic feel. The recipe is more varied than the main one at Abydos, yet it is more homogenous than the recipes of the cult building inside the enclosure. Such variation is to be expected when using a wide range of ingredients, and could also indicate batches from different pools and/or manufacturers. Overall the ingredients do appear to follow an overarching recipe.

The first phase bricks are heterogeneous, sandy, with a high midden-waste content from both domestic and workshop areas; they use very little chaff and show significant mixing of different sediments, suggesting that fresh silt may have been at a premium. Chaff may not always have been readily available (Homsher 2011 pers. com), or may have been a premium commodity, particularly in view of drought, in a narrower region of the Nile Valley such as Hierakonpolis. Overall, the first phase bricks show less expertise. The first phase may be compared to a 'poor man's' enclosure, showing restricted access to materials and less expertise in construction, either deliberate or enforced. The variability and composition of the first phase bricks suggests the ability to make significant amounts, about 2,000m^3, of strong bricks with reduced access to prime materials, such as silt and chaff, and what appears to be less production control. The sedimentary layers point to poor mixing, which could indicate less care or hasty production.

Bricks could have been reused, as the Hierakonpolis enclosure was built on an old Predynastic cemetery and by a Predynastic/Ed settlement. Old bricks from different productions, as would be expected in a settlement or cemetery, were broken down and left to soak. This would explain some of the micro-fragments of Predynastic pottery found in the bricks. Combined with poor mixing, the dissolving bricks would have left sedimentary layers. The initial enclosure at Hierakonpolis was planned to be smaller than the one at Abydos. It therefore required less material. The mudbrick recipe used appears to have required less control. Production was domestic in scale and quality, though still better than production entailed in the cult building at Abydos. As such it was possible for Khasekhemwy to employ local brick manufacturers who knew how to make good quality bricks with less prestigious materials than at Abydos. The building logistics point to the fact that the Hierakonpolis enclosure was only planned to be a subsidiary of the Abydos one, as the lower quality ingredients suggest.

The second-phase bricks share similarities with the Abydos enclosure. They are siltier, more homogenous, cleaner, with a higher organic content and large inclusions, and have less clay, which also varies less in content. Yet the bricks are sandier than Abydos, which is also due to the type of local sediments used. The fact that they used palaeo-silts in conjunction with much darker alluvial sediment may point to a deliberate, local avoidance of using prime alluvium. Still, they seem to have included alluvial sediment in the second phase while the first phase appears to have more material from the pit rich in palaeo-silt and Sahaba silt (south of the wadi mouth; fig. 6.39). The bricks also present very faint sedimentary layers and chunks, which may point to local tolerance for poor mixing and/or that they had to manufacture bricks quickly to build the enclosure rapidly for both phases. The recipe may therefore indicate that the brick makers retained a local workforce but brought in expertise and access to prime materials that enabled the superior quality comparable the Abydos bricks, potentially as a result of a newly found royal authority. By bringing the walls of the second phase to the same height as those of the Abydos enclosure and the construction of a perimeter wall, both with cleaner, more homogenous and siltier bricks, and the use of grass mats, the second phase respected the initial architectural design (Friedman 2007) but modified it in a way that made it resemble the enclosure at Abydos. The composition of the second-phase bricks mirrors this process. A further discussion of the implications of the mudbrick analysis at both Abydos and Hierakonpolis is offered in Chapter 9.

Overall, the relatively low level of clays at both Abydos and Hierakonpolis probably reflects long traditions of working with, and countering the negative effects of, sediment with high-smectite clay content that characterises the Nile Valley's alluvium and causes bricks to crack by either expanding or shrinking with moisture levels. These effects were countered by limiting the amount of clay used and by mixing the alluvial sediment with other sediments, some sandier, and with other forms of temper to reduce clay content. Despite lower than normal clay contents, binding was achieved by adding ash, or charcoal, to counter the loss of the clay, which is the main binding agent. This study is able to confirm that a practice only known from the later NK, which was only ever recorded at Karnak (French 1981), was already practiced in the ED at Abydos and Hierakonpolis, and perhaps as early as the Late Predynastic at Hierakonpolis.

In summary, Khasekhemwy's mudbrick consumption remains unequalled. Table 6.7 gives rough estimates of his mudbrick consumption for his enclosures alone. Two estimates are given for the perimeter walls, as their height is unknown.

	Abydos Encl. (11 m)	*Abydos PW Est. 1 (6m high)*	*Abydos PW Est. 2 (12m high)*	*Abydos Total Est. 1 & 2 (6 and 12m high)*	*HKA (2.5m high)*	*HKB (11 m)*	*HKB PW Est. 1 (6 m high)*	*HKB PW est.2 (12 m)*	*HK Total Est. 1 & 2 (6 & 12m)*
Mudbrick Masonry Vol. (est.) m^3	20,020	7,488	14,976	27,508 - 34,996	1,190	8,335	4,290	8,850	13,815 - 18,105
No. Bricks (est.)	6,563,934	2,455,082	4,910,164	9,019,016 11,474,098	529,200	3,019,928	1,554,348	3,108,696	5,103,476 6,657,824

Table 6.7. Estimates of volume of mudbrick consumed for Khasekhemwy's mudbrick enclosures at Abydos and Hierakonpolis (my calculations from Dreyer *et al.* 1998, 2000, 2003, 2006; Friedman 1999, 2005, 2007).

Granite

A pink granite column base was found near the cult building in the centre of the enclosure, along with numerous other fragments (figs. 6.40; Friedman 1999: 11), and a granite lintel inscribed with Khasekhemwy's name was also found in the precincts (Alexanian 1999: 14). Several fragments from larger inscribed granite blocks were discovered near the entrance of the enclosure, most likely remains from robbers dragging the decorated blocks out of the enclosure to heat them in order to break off smaller bits for reuse (Alexanian 1999: 14). The granite is the same throughout, indicating a common quarry source and thereafter probably also a common local use for the cult structure inside the enclosure (Friedman 1999: 11). Given the fragmentary nature of the evidence, it is impossible to extrapolate volumes of granite consumed, especially since the numerous fragments imply that the bulky units were broken down subsequently for reuse. What is clear is that granite, in whatever quantities, was present and would have been a costly material to use. Although it was not tested for provenance, it most likely would have been transported downstream from the Aswan quarries 120 km south (fig. 6.1). Both manufacture, including rough and fine dressing, and particularly the engraving, and transport would have been extremely time consuming, granite being one of the hardest stones to cut and from a distant quarry. The only known precedent for the use of granite in an RMC was Den's tomb at Abydos where it was used to pave the floor of his burial chamber (Amélineau 1899: 124-5; Petrie 1902: 10-1; Dreyer *et al.* 1990: 76-7, 1998: 142-8). This shows that although more modest in size than the Abydos enclosure, the Hierakonpolis enclosure was important to Khasekhemwy and his reign, and possibly just as costly as its Abydos counterpart (Friedman 1999: 9).

Finally, although it is hard to estimate the volume of granite consumed, the evidence for the use of granite for finer architectural elements in Khasekhemwy's Hierakonpolis enclosure is significant (Alexanian 1999), as is the use of limestone masonry in his tomb at Abydos. Additionally, a massive limestone enclosure at Saqqara is tentatively dated to his reign and may represent much more considerable stone consumption. This in fact would be the first ever recorded, large-scale consumption of roughly hewn stone for masonry purposes. We shall now consider this structure as potentially one of his undertakings to provide context to his building programmes, to his large-scale use of mudbrick and to his stone consumption (Mathieson *et al.* 1997, 1999; Mathieson 2000; Van Wetering 2004).

6.4. Saqqara

Khasekhemwy may also be responsible for the construction of a third monumental limestone enclosure at Saqqara, known as the Gisr el-Mudir or 'the mound of the boss', in reference to the first 'mudir' (boss in Arabic), Abdel Salam Hussein, to investigate it in 1947 (figs. 6.1, 2.13, 6.41; Mathieson *et al.* 1997: 21). Although Hussein's finds remain unpublished and the enclosure remains to be systematically excavated, its shear scale means that it was noticed by early explorers such Vyse and Perring (1840) and de Morgan (1897), who made note of it on their maps. The information presented here is drawn essentially from evidence provided by the recent survey and brief excavation Mathieson and his colleagues carried out from 1990 to present (Mathieson and Tavares 1993; Tavares 1995; Mathieson *et al.* 1997, 1999; Mathieson 2000; Price 2009). The structure remains unfinished.

Dates for the Gisr el-Mudir remain tentative, ranging from the ED to the early 3rd dynasty (Swelim 1983: 33-5; Tavares 1995: 1136). Yet, a late 2nd dynasty date is generally accepted and followed here. The discovery of beer jars that are characteristic of the late 2nd and early 3rd dynasty, the monument and masonry type and wall batter, which are all typical of the ED (Tavares 1995: 1136), and the relatively poor execution of the masonry in comparison to later structures, suggests that the monument most likely belonged to Khasekhemwy, especially as his successor Djoser's RMC exhibits extremely high standards of craftsmanship (Mathieson *et al.* 1997: 38-43). Furthermore, an entry on the 5th dynasty royal annal known as the Palermo Stone records the building of a temple out of stone known as the "goddess endures" under Khasekhemwy's reign, which some suggest might be the Gisr el-Mudir. However, it may also refer to the stone temple at El-Kab, the sister town of Hierakonpolis (Wilkinson 2000: 118-32; Van Wetering 2004). Regardless, it is significant to the discussion that Khasekhemwy built a monument out of stone, adding to the likelihood that he was responsible for the oldest free-standing stone masonry structure in the world, by far larger than any structure at Saqqara. The pottery found in the enclosure indicates that the enclosure would have been built in the latter half of his reign. Combined with its location and unfinished state, the enclosure perfectly fits with a south to north political progression as does its scale and material use. The monument's unfinished state, the evidence for intensive building activities on the Saqqara plateau during Khasekhemwy's reign (Mathieson *et al.* 1997; Regulski 2009: 228), and Khasekhemwy's inclination towards monumental building at Abydos and Hierakonpolis support such an ascription (Mathieson *et al.* 1997: 38-43; Van Wetering 2004: 1071). A late 2nd dynasty date and ascription to Khasekhemwy is further supported by the evidence presented below and discussed in Chapter 9, but can only be confirmed through future excavation (Dodson 1997; Davies and Friedman 1998: 67; Friedman 2005: 27). While secure dating would help clarify the function of this enclosure, the idea that it was an unfinished RMC, fort or a cattle enclosure have not been ruled out (Maragioglo and Rinaldi 1963: 53; Lauer 1966: 447). The evidence suggests that it is most likely a stone version of the traditional mudbrick enclosures found at Abydos (Stadelmann 1985: 295-306; Regulski 2009: 227).

Location ad Layout

The Gisr el-Mudir, at Saqqara, was built 450 km north of Abydos and 650 km from Hierakonpolis (fig. 2.13), a site that, from a wider landscape perspective, is at the core of a central area defined by a number of ED elite cemeteries (Chassinat 1901; Petrie 1913; Hendricks 2009; Tristan 2009), with Abu Rawash defining the northernmost (23 km north) and Tarkhan the southernmost (55 km south just south of Meydum) boundaries – these boundaries are returned to in Chapter 9. The enclosure was built 1.5 km from 2nd dynasty royal tombs, a distance comparable to that which separates the ED enclosures and royal tombs at Abydos and that make it the westernmost monument at Saqqara (see tables 9.1, 9.3). As with all structures built at Saqqara, but unlike the royal tombs and enclosures at Abydos, which are in a low-lying position before the wadi, the Gisr el-Mudir was placed above the two main wadis and lies west not east of the royal tombs – of which none have been associated with the Gisr el-Mudir (45 m above the valley floor; Mathieson *et al.* 1999: 22). The Gisr el-Mudir is equidistant (3 km) from the entrances of the two Wadis Abusir and Tafla that demarcate the northern and southern boundaries of the Saqqara plateau respectively, with the Wadi Abusir curving southwards to form a western boundary to the plateau and likely providing main access to the site from the ED capital thought to be its entrance (fig. 2.13; Tavares 1995: 1137). It is thought that the likely location of the capital by Wadi Abusir and the gap in the western extremity of the unfinished south wall visible in the resistivity map supports access via the Wadi Abusir, as neither the north, east and west walls present any entrances. The southeast corner was never built, but being the point of entry for many of the earlier and subsequent enclosures, the area could have been a point of access. The fact that the entrance is near a mudbrick platform used to move materials and that it was connected to an artificially enhanced, narrow wadi 500 m to the west that led to an area we know served as a quarry (Klemm and Klemm 2010: 14-5), as well as its topographical relationship to the 2nd dynasty structures on the plateau, including the Gisr el-Mudir, make it a likely access route. Perhaps this access was a more practical one used for the movement of material from the valley, but was not the main ceremonial entrance to the west, which shares similarities in width with the Abydos processional way.

The monument's placement also means that the enclosure would have been approached in a manner similar to the Abydos ones, with the enclosure encountered before the 2nd dynasty royal tombs to the east, showing greater continuity than initially anticipated. Its placement also shows more concern for a centred position on the plateau and connection with the two major wadis than with visibility from the valley, emphasising large-scale access, likely connected with the large-scale grouping of people suggested by the scale of the enclosure. If 1 m^2 is allocated per person, it could have held up to c.246,000 individuals, which is much closer to the numbers one would expect of a capital. Both wadis may have been used as access routes for grand ceremonies. The enclosure's placement means that while it would not have been visible from the valley in the immediate vicinity, it would have been visible from further afield, the Western and Eastern Deserts. Perhaps of crucial importance, it would have been visible from the major, local ED cemetery, known as Helwan, across the valley. Helwan shows great social diversity with the burials of royal children, high officials and less high-ranking individuals (Köhler 2008: 398). Thus, compared to the earlier Abydos counterparts, much continuity in practice is visible but with a significant increase in scale and magnitude.

The enclosure has truly monumental proportions measuring 430 x 650 m with battered walls 14-17 m thick. The original height of its walls, which stand 4-5 m high today, is unknown (Mathieson *et al.* 1997: 53). Inclined walls are a common feature in 4th dynasty RMCs and are a cost efficient way of building strong walls. The enclosure covers a surface area of 246 hectares, 45 times that of Khasekhemwy's enclosure at Abydos, 60 times that of his enclosure at Hierakonpolis, twice that of his immediate successor Djoser and four times that of Sekhemkhet's at Saqqara (Mathieson *et al.* 1997: 53). It is the biggest enclosure built in Egypt, in addition to being the oldest free-standing stone-masonry structure in the world. There are no signs of niched facade decoration, unlike the mudbrick enclosures or later enclosure-like perimeter walls of Djoser and Sekhemkhet RMCs at Saqqara. Except for a mudbrick platform in the southeast corner, no other structures were detected within the enclosure, ruling out the existence of a tomb or a chapel (Mathieson *et al.* 1999: 38). Yet, given that the structure was left unfinished, and given how disturbed the area inside the enclosure is with later burials, one should not exclude the possibility that a structure may have existed but leaves no trace (Mathieson *et al.* 1999: 38).

It is unclear how long it took to build the Gisr el-Mudir. Yet, evidence suggests a hasty completion. Three different construction methods are attested: (a) a hollow construction for the east, west and south walls, which consisted of two masonry walls, the internal and external faces of the enclosure walls, and infilling the gap in between them with rubble and sand (fig. 6.42); (b) solid masonry (as opposed to the hollow construction) for the north wall and two buttresses built against the outer face of the north and possibly west walls, the function of which is unclear (figs. 6.43, 6.44); and (c) solid masonry formed of slightly larger blocks for the corners (Mathieson *et al.* 1997: 36). The three methods point to different phases of construction as well as different degrees of expertise in the labour force. The masonry is comparable to that of Sekhemkhet's unfinished pyramid at Saqqara (300 m to the east) and that of the Layer Pyramid at Zawyet el-Aryan 9 km north (see sections 7.2 and 7.3), but it is simpler, with less regular blocks and skill in execution (Mathieson and Tavares 1995: 29). There is also a heavy reliance on earthen building methods as were are about to see.

The north wall shows a high degree of craftsmanship in both construction and execution, betraying a desire to building a strong, stable wall (fig. 6.43). The foundations were secured by levelling the desert surface and cutting a shallow trench in the bedrock into which a masonry foundation course was laid and onto which a very hard mud-mortar was poured and extended beyond the internal face of the wall for at least 4.4 m into the enclosure to form a very hard, levelling, buttress-like platform, which increased the stability of the wall. Unlike the other three walls, the north wall's interior consists of well-laid and carefully articulated blocks of good quality limestone that were cemented together with mud-mortar. The casing is made of roughly cut, undressed blocks of poorer quality limestone, the same as those used in the rest of the structure, (Mathieson *et al.* 1997: 24-6).

All remaining three walls are a hollow construction. The foundation courses of the west wall were laid directly on the unprepared desert surface. However, as with the north wall, the first two courses were cemented together with fine packed sand and a thick mud-mortar that extends at least 25 m east into the enclosure and forms a platform. The top 5 cm are a very compacted matrix that indicates that the platform served as a pavement (Mathieson *et al.* 1997: 21; Mathieson 2000: 37). The platform and the four lowest courses of the wall's internal face were then coated with a hard grey plaster (Mathieson *et al.* 1997: 21-35), creating a plane surface common in traditional earthen construction. The west is formed of two outer masonry faces built with partially dressed blocks of uneven dimensions and backed with smaller blocks of limestone cemented together with mud-mortar (Mathieson 2000: 37). The hollow construction was filled with two types of prepared mixes; a coarser mix was poured onto the backing masonry, and the rest of the infill, the bulk of the wall, consisting of a finer sandy matrix was poured over it (Mathieson *et al.* 1997: 23). The hollow and infill construction method is attested early on in the mudbrick funerary architecture at Saqqara or Abydos for instance (Emery 1939).

The east wall is also built according to the hollow and infill technique but is the most damaged; most of the blocks were later reused as building material. The east wall is also built on the unprepared desert floor (see table 9.5; Mathieson 2000: 37). Yet, about 4-6 m of *tafl* (calcareous marl which gave its name to the Wadi Tafla) and limestone were cut away at the base of the wall's external face, creating a plinth that is flush with the wall, providing construction material for the enclosure and a means to make the wall more impressive from the east (Mathieson 2000: 37). Making the east wall more intricate or impressive through decoration was a common feature of mastaba tombs and enclosures, here achieved by reverting to a traditional, local, Saqqara-based stone-cutting expertise rather than the customary method of bonding that can only be achieved with squared blocks.

As with the north wall, a foundation trench was cut for the south wall, and the first two foundation courses were cemented using a thick mud-mortar (Mathieson 2000: 37). The south wall, also a hollow construction, was left unfinished and its execution is the poorest of all, repeatedly showing vertical joins throughout the masonry face. The cracks are coated with heavy mortar and/or filled with small blocks of limestone in an attempt to palliate the damage the faults caused. However, despite thee attempts, the vertical lines caused the wall to collapse in a number of places (Mathieson *et al*. 1997: 35).

The corners are the most intriguing and revealing feature of the enclosure. Corners, the weakest part of any built structure, were built using solid masonry and slightly larger blocks than in other parts of the structure, indicating that effort went into strengthening them (Mathieson *et al.* 1997: 36). Strengthening corners with stone is often observed in earthen architecture (Van Beek 2008), as seen with Aha's mudbrick enclosure at Abydos for instance (Adams pers. comm.). The treatment may point to a transferral of earthen building technique to stone. However, as for the 2nd construction phase of Khasekhemwy's mudbrick enclosure at Hierakonpolis, the corners were poorly made, formed with headers meeting, with the limestone blocks piled one on top the other, creating a vertical join of weakness, undermining attempts to strengthen the corners with solid masonry. This suggests that the corners were not raised first, before the walls, but rather as the walls were built. If the walls were raised independently at different times, as has been suggested based on the north-south difference in quality, then this shows that the specialist workforce of the north wall were not available for the others. Perhaps they started with the north wall and had to leave. Although this is at the limit of what the evidence enables us to say, the stone workforce may have moved to Abydos to oversee the use of limestone for Khasekhemwy's Saqqara-style tomb. The question of moving workforces will be returned to in Chapter 9. If the walls were raised simultaneously, the treatment of the corners and the difference in execution visible with all four walls suggests that different teams of workers with different expertise each brought the walls up simultaneously.

Two stone buttresses were built with solid masonry against the exterior of the north and west walls. Their function remains unclear. The north wall buttress is 6.25 m and was built with undressed blocks that are similar in size to those used in the rest of the structure (0.75 x 0.5 x 0.3 m in average) but differ in that they are regularly cut. That and the fact that the buttress is not part of the north wall's final casing but is built abutting it, indicate that it was built at a later date (Mathieson *et al.* 1997: 36). The west wall's buttress was formed of limestone courses. No more information is provided; however, the excavators suggest that it may have been designed to hold the casing masonry wall while the core was filled in with rubble (Mathieson *et al.* 1997: 24-35).

A mudbrick platform was built on a basin-like part of the plateau in the southeast corner of the enclosure, just west of a flattened area. The platform was likely used to facilitate the movement of heavy loads (fig. 6.45) as it is made with a single course of poorly articulated bricks laid directly on the sand, has thick ridges 10 cm wide and 20-60 cm apart and was entirely coated with an extremely hard plaster, presumably due to repeated pouring of water. There is no evidence, such as walls or wedges, to indicate that it supported a built structure (Mathieson 2000: 18-21).

It is estimated that 100,000-120,000 m^3 of material, including limestone, rubble and mortar, were used to build the enclosure. The hollow construction method used for the majority of the enclosure means that 60 % of the material used consists of prepared sand mixes (two types) used to fill in the interior of the east, west and south walls. Roughly shaped limestone blocks represent about 25 % of the total volume of material used for the enclosure. On this basis, it is estimated that a minimum of 25,000 m^3 of limestone was quarried, with the soft variety making up most of the masonry; the harder variety was only used for the core of the north wall. Although no scientific testing was carried out on the limestone of the Gisr el-Mudir, both varieties – the softer variety which ranges from a more or less fossiliferous, sandy, marly limestone to a calcareous sandstone – belong to the Middle Eocene ravine beds of the Maadi Formation. Both were available locally (Klemm and Klemm 2008: 55-6). Conveniently, the limestone at Saqqara occurred naturally in 20-60 cm thick sheets separated by layers of calcareous marl (*tafl*), which was used for the mortar (Mathieson *et al.* 1999: 24). The sheets' height predetermined the blocks own height, the blocks which are 0.75 x 0.50 x 0.30 m on average, are irregularly cut and vary in depth and length as a result (fig. 6. 46; Mathieson *et al.* 1997: 24; Klemm and Klemm 2008: 55-6). The unsystematically shaped blocks could be the result of quarrymen working with natural cleavage lines, as seen with the burial chamber blocks at Abydos, making the cutting easier (Petrie 1901: 13). Although the description given in the reports is not systematic, the stones appear predominantly undressed, although the casing blocks of the west wall may have been roughly dressed (Petrie 1901: 22-3). The mortar was applied in thick layers. Mortar is less strong than the limestone and as a thick layer it created a line of weakness and undermined the cohesion of the structure.

Survey of the area helped determine several possible quarries (figs. 6.8, 6.10). One was located along the east wall of the enclosure, where the 4 m of *tafl* and limestone were cut away to form the plinth for the east wall and where the quarrying served several purposes at once: levelling, enhancing the structure and generating blocks for the masonry and *tafl* for the mortar. The Abusir Wadi floor 1.5 km north and west of enclosure was also cut away to build 2nd and 3rd dynasty monuments, considerably enlarging the wadi (Mathieson 2000: 36-7). Petrographic evidence has shown that the limestone cliffs of the Saqqara plateau's eastern escarpment 2 km from the Gisr el-Mudir were quarried to build a number of 3rd dynasty structures on the Saqqara plateau (Klemm and Klemm 2010: 14-5). This source of limestone is a less likely source than the above-mentioned quarries, which are conveniently placed closer to the enclosure. Still, stone from the limestone cliffs may have been used. An ED-OK quarry 4 km west of the enclosure also exists in the western desert. It is the furthest and less likely potential source of limestone for the Gisr el-Mudir (Aston *et al.* 1994).

The harder limestone, which has often been confused for the Tura-Maasara limestone used in RMCs from the 4th dynasty onwards, is more yellowish (with a patina), porous and coarser-grained than the Tura-Maasara limestone. It is much easier to dress and does not compact when polished, making it more resistant to weathering when used in architecture (Klemm and Klemm 2008: 56-7). As with the soft variety, it also occurs in sheets, meaning the blocks also vary in dimension, but the sheets appear to have been cut differently with the sheets' thickness predetermining the width (0.30-0.60 m) rather than the height of the block (Mathieson *et al.* 1997: 24; Klemm and Klemm 2008: 55-6). Hence this variety of harder limestone presented many advantages over the Tura-

Maasara variety used later. Testing would be necessary to confirm the exact provenance of the fine limestone used for the Gisr el-Mudir. The harder, rarer variety available at Saqqara was exhausted by the start of the 4th dynasty, which means that the exact source of the Saqqara fine limestone can no longer be located (Klemm and Klemm 2010: 14). Still, although it cannot be proven at this stage, it is accepted that the fine variety available locally was likely employed for the north wall's core masonry. The fact that it was used for the core rather than the casing is intriguing and supports an earlier rather than later date for the enclosure, as all subsequent monument builders were aware that using the harder variety as casing provided more resistance to weathering.

In addition to a stone-cutting workforce being already present at Saqqara, as the large rock-cut tombs of the second dynasty indicate, the onsite availability of both soft and fine limestone in sheets separated by material that provided the bulk of the mortar created a situation in which building materials were more accessible. Limestone was easier to quarry and shape than in other localities in Egypt, where blocks had to be shaped fully. This may account, in conjunction with the hollow construction technique, for a monument the size of the Gisr el-Mudir at Saqqara, built late in Khasekhemwy's reign. Mason's marks painted with red ochre were found at the Gisr el-Mudir (Mathieson *et al.* 1997: 26). One, painted on a dressed face of a block near the north wall, may actually have belonged to the north buttress. However, four were found on undressed limestone blocks *in situ* of the internal face of the west wall, painted at irregular intervals (Mathieson *et al.* 1997: 35). Their placement and the fact that "a triangular lump of red ochre pigment was recovered from the mud-mortar matrix abutting the base of the wall" (Mathieson *et al.* 1997: 35), suggests the marks were painted once the blocks were in place. Although the symbols are too poorly preserved to be compared with later ones and remain enigmatic, they are the earliest ones found painted on a stone monument. Considering they were painted once the blocks were placed, rather than recording storage information, the marks may have helped keep track of who brought the block, as with later RMCs. In any case, their presence suggests that a certain degree of organisation was already in place, which was a necessity given the size of the operation. The evidence therefore points to a stone-extracting workforce that knew how to quarry stone in a time-efficient manner. The north wall shows that smaller groups of specialists were already available at the time the Gisr el-Mudir was built. Discussion of these results in connection to the evidence form Abydos is discussed further in Chapter 9.

Earthen Construction Materials

Earthen construction materials, such as mudbrick, and techniques, such as the heavy reliance on thick layers of mortar, plaster or rubble, represent a significant secondary category of construction material that is key to the enclosure's structural integrity. Although mortar, plaster and rubble infilling techniques were not only used in earthen architecture, in the context of early Egypt's construction history, these methods were developed first in the context of earthen architecture and are hereby seen part of this tradition, something which the patterns of use of these methods in the Gisr el-Mudir seem to confirm. Earthen techniques, which are the focus of this final section, are used throughout the structure, and make the Gisr el-Mudir a perfect bridging monument between earlier mudbrick- and subsequent stone-dominated royal mortuary building activities.

The core infill and bulk of the enclosure consists of two prepared mixtures. The main, upper mixture consists of "coarse to fine sand, silt, small limestone fragments and chippings and pebbles and flints" (Mathieson *et al.* 1997: 23). It is estimated that 36,000 m^3 was used. The secondary infill used for the lower portions is much coarser and made up of coarse sand and medium to large limestone fragments" (Mathieson *et al.* 1997: 23) and represents 23,550 m^3 of material. In total 60,550 m^3, or 97,000 metric tons (but probably more as this is based on the weight of sand alone) of rubble was used for the Gisr el-Mudir.

Vast quantities of mortar were used to make up for the unevenness of the blocks, to fill gaps associated with poor block-laying, secure foundation courses and create levelling and buttressing platforms. Although the mortar was not tested for composition, visual observation determined that it is mud and, to a lesser degree, *tafl*-based, with coarser inclusions that range from limestone flakes and chippings to desert flint and pebbles (Mathieson *et al.* 1997: 24). Different recipes, determined by the varying proportion of *tafl*, mud and type of coarse inclusion, are observed throughout the enclosure. A harder mortar was used for the foundation of the north and west walls. It is estimated that at least 40 % of every masonry wall was mortar, representing 16,000 m^3 or 16 % of the total volume of material used for the enclosure. Yet, this would have been greater, considering that mortar was also used in the rising joints, the lower courses and the levelling and mudbrick platforms. The platform extending from the internal face of the west wall consists of a "hard packed sand with the top 5 cm consisting of a very compacted matrix containing mudbricks, limestone fragments and fine pebbles imbedded in a way that indicate that it was also a pavement" (Mathieson *et al.* 1997: 21-35). The *tafl*, having a similar composition to the limestone, would have increased the cohesion of the mortar if used in the right proportion, but not as much as gypsum, which would have been ideal. The local *tafl* marls most certainly provided the bulk of the material, especially the clay particles, while the mud/sediment and water were carried up from the valley over a minimum distance of 3 and/or 1.5 km depending on whether the Wadi Abusir or the smaller Unas causeway was used. A rough estimate gives 16,000 m^3, or 16 tons of water used in the same proportion as the sediments for mortar. The water would have been collected from lake Abusir, a canal, or the river itself. The limestone flakes and chipping inclusions came from the working of blocks on or near the site, and the desert flint and pebbles from the clearing of the desert surface in preparation for the enclosure and for quarrying; mounds of these pebbles were found running north-south just east of the enclosure where the desert had been cleared for quarrying west of Sekhemkhet's enclosure (Mathieson 2000: 36). Thus whether natural or anthropogenic, they are conveniently recycled refuse from activity zones in the immediate environment. Mortar needs to be made onsite as it is being used, representing a vast enterprise, considering the distance of the source from the valley.

Plaster was employed on the faces of lower courses of the west wall to further cement the wall and the levelling buttresses, and create a unified appearance. A hard grey facing plaster protected the thick bedding mortar of the levelling buttress of the west wall. A mud and gypsum plaster was used to coat the mudbrick platform in the enclosure. It is different from the other plasters in that it is composed of dark grey brick dust, orange sand, probably the reddish breccia-type sand south of the enclosure, and fine white gypsum from decomposed local limestone (Mathieson *et al.* 1997: 21-35).

Mudbrick is only a secondary building material at the Gisr el-Mudir. Two groups are noted, the rectangular ones that have a dimension similar to Khasekhemwy's Hierakonpolis bricks (ph. A 25 x 12 x 9 cm, ph. B 30 x 14 x 7 cm) and were used for the platform built in the south-east quadrant of the enclosure to facilitate the movement of bulky items; and square ones that are archaic in style and most likely were reused as infill in sections of the north wall and buttress (Mathieson *et al.* 1997: 18-9), and to build a rubble and mudbrick buttress against the internal angle of the northwest corner to make up for the corner's inherent weakness (Mathieson and Tavares 1993: 29). None of the bricks were tested for composition and sourcing, due to time and access restrictions. However, limited visual observations give some insights into manufacturing strategies and the organisation of work.

The bricks used for the platform are light grey and appear to Mathieson and colleagues to be made of fine silt with some sand; neither organic nor any other types of inclusions normally found in domestic bricks were present. Domestic bricks tend to have a high percentage of broken pottery or organic materials, which suggests that the bricks were manufactured specifically for use in this structure (Mathieson *et al.* 1997: 18). Although ideally brick manufacture takes place at the building site, it seems reasonable to argue that the manufacture took place in the valley, as it is practical to make bricks there and bring them up either by human porter or donkey, rather than transport all the individual materials up to the high desert. The Wadi Abusir and smaller Unas Causeway wadi were likely used as natural ramps from the valley. Still, given the amount of water needed to be brought up for mortar manufacture, and the limited amount of bricks required for the platform it is possible that the bricks were made on site.

The most complete examples of the square mudbricks used as infill in the north wall measure approx. 12 x 12 x 7+ cm. As mentioned, the square shape suggests an archaic date and that these bricks were likely reused rather than manufactured specifically. The pure dark grey colour and silty texture with no obvious organic or mineral inclusions as normally found in domestic bricks, suggests that they may have been made specifically for funerary architecture and therefore probably reused from nearby structures (Mathieson *et al.* 1997: 18, 24). A different kind of squarish mudbrick of unspecified colour containing organic temper, much larger (18 x 20+ x 12 cm) than the other type, was used to infill sections of the probably later, north wall buttress. The organic temper may suggest they were produced for domestic use and reused here, though this remains uncertain (Mathieson *et al.* 1997: 26). Bricks used for the corner buttress were not described in reports.

In summary, I propose that the monumental limestone enclosure at Saqqara is Khasekhemwy's. Attribution to Khasekhemwy provides greater context for his structures at Abydos and Hierakonpolis. Locationally, while initially seeming different from Abydos, it actually shares many similarities. It would have been encountered before the royal tomb cluster, from which it is also separated by a comparable distance.

Looking at the building method employed at the Gisr el-Mudir and combining volume estimates with a more detailed assessment of material types, provenance and manufacture properties enable a clearer understanding of the effort and building strategy that unfolded for the Gisr el-Mudir. A lot of the strategies visible at the Gisr el-Mudir are testament to the enclosure's early date, as they betray a very earthen-architecture-driven logic and a minimal yet growing knowledge of stone masonry. Although imperfect in a way that a developing technology may be, this monument also demonstrates ingenuity and clever use or reuse of material and manufacture by-products. It also shows that Khasekhemwy had access to a large workforce that operated largely in a stone-cutting framework, having access to a smaller group of more specialised stone workers who were able to lay masonry (north wall), and a larger unspecialised workforce which was responsible for the bulk of the volume of the structure (infill). Some degree of organising is also visible in the masons' marks. It is interesting that the masons' marks differ from the Abydos markings. Yet in both cases the quarrymen made use of the natural cleavage lines. Although this remains at the limit of what the evidence enables us to say, the patterns of construction do beg the question of whether the specialists moved to Abydos for Khasekhemwy's burial chamber. The way the corners are treated is also vey interesting. The implications of Khasekhemwy being responsible for this monument will be discussed further in Chapter 9.

6.5. Summary

The main lines of the analysis are summarised below to provide context for the next part of the analysis that focuses on stone-dominated building projects (Chapter 7 and 8), starting with that of Khasekhemwy's immediate successor Djoser. Locationally, Khasekhemwy places his monuments at Abydos with that of his immediate predecessors and those of Egypt's first kings, so that a straight line clearly connects the settlement, shrine and his enclosure with his tomb and the local wadi, to which his tomb remains the closest (Richards 1999; Magli 2011). The settlement-shrine-enclosure connection or line of site is also visible in the layout of his tomb at Abydos. The location of the enclosure at Hierakonpolis follows a similar logic to that at Abydos. The enclosure is in a similar position in the local landscape. One can draw a straight line between the Nekehn temple, enclosure and the wadi, potentially indicating where a tomb may have been started for him. In some respects the Saqqara enclosure also fits in the landscape as a Saqqara version of the Abydos tradition in that it would also have been seen before the tomb cluster, from which it was also slightly distanced. It also held a very central position on the plateau, perhaps reflecting a desire to be accessed via both northern and southern wadis. Given the size, although this is at the limit of what the data enable us to say, the Saqqara enclosure may have been host to a larger ceremony designed to integrate a significantly larger group, from the north and south, compared to the smaller enclosures at Abydos or Hierakonpolis.

Materially, all of Khasekhemwy's monuments are significantly larger than any known previous monument, requiring more resources both human and natural. Khasekhemwy also departs from tradition in a number of significant ways. Though the majority of tombs at Abydos show distinct building stages, the sheer number in Khasekhemwy's case is only previously attested at Saqqara, in Hotepsekhemwy's tomb (Lacher 2011). It is also significant that the layout was modified early on to resemble a Saqqara royal tomb in layout, and that limestone was introduced. Also, his associated enclosure at Abydos was never built with the intention to be brought down, and he had another such structure at Hierakonpolis, which he likely returned to, to make it resemble the Abydos one in size and overall layout; there he also combined mudbrick with stone, in this case granite, a southern stone for his southernmost enclosure. The mudbrick analysis of both enclosures at Abydos and Hierakonpolis reveal different recipes that have interesting implications for understanding Khasekhemwy's access to resources, both natural and human, and the organisation of work of his mudbrick projects, the implications of which will be returned to and discussed further in Chapter 9. If the ascription of the Gisr el-Mudir is correct, then Khasekhemwy's royal funerary building activities would therefore have spanned the widest geographical and material breadth known for any ED and OK ruler, and the change in locations and materiality of his monuments would reflect very real responses to changes in political power. The possible logistical, social and symbolic implications of the locational and material parameters of Khasekhemwy's monumental building projects will be developed further in Chapter 9.

CHAPTER 7
DJOSER TO HUNI

This chapter provides a chronological site-by-site analysis of the locational and material parameters for the five RMCs known for the 3rd dynasty, the period after Khasekhemwy's reign. As discussed in Chapter 2, while the chronology is well established for the start of the 3rd dynasty, notably between Djoser, Sekhemkhet and Khaba, it remains unclear how many kings ruled in the latter part of the 3rd dynasty or what monuments can be securely attributed to a known ruler of the end of the 3rd dynasty. Based on the evidence reviewed in Chapter 2, the sequence proposed here starts with Djoser and Sekhemkhet's RMCs at Saqqara, followed by Khaba's at Zawyet el-Aryan and the unascribed ruined mudbrick monument at Abu Rawash and the often ignored earliest construction stage at Meydum (E0), which here is tentatively attributed to Huni (see Chapter 2).

7.1. Djoser

Djoser's reign, which lasted 19 years, or 38 if the taxation was biennial, is considered a milestone in Egyptian history, one that marks the end of the ED and the start of the OK. The compilers of the NK king list (Turin Canon) saw Djoser as the founder of the 3rd dynasty and more importantly, of the state (Stadelmann 1995). Echoing the major political development that Djoser's reign represents for early kingship in Egypt, his RMC is also seen as a milestone in the evolution of royal monumental architecture. It is the first to have a pyramid and use stone as its dominant building material. Architectural features traditionally made of perishable materials are for the first time converted into stone. Djoser's RMC is the first recorded instance of the use of fully dressed stones for masonry. Later known as 'the one who opens stone', Djoser is considered the first ruler to instigate systematic quarrying (Klemm and Klemm 2010: 12-3). The achievements visible in his RMC are such that, by the NK his architect, vizier and Great Priest of Ra, Imhotep, was deified. It is interesting to consider his RMC building program and associated political achievements in the light of the developments of his predecessor Khasekhemwy.

Location and Layout

Djoser abandoned the long-established royal cemetery preferred by his two immediate predecessors Peribsen and Khasekhemwy in the south of Egypt at Abydos in favour of that which the early 2nd dynasty rulers founded at Saqqara, 470 km north of Abydos (fig. 1.1, 7.1). In keeping with royal tradition at Saqqara, Djoser's RMC was built on the plateau (50 m ASL), rather than in the wadi palaeofan, as were the Abydos ones. It was placed in a commanding position between the wadi and the escarpment (750 m east) formed by a steep cliff, the appearance of which was significantly accentuated by quarrying activities (see tables 9.1, 9.3; Klemm and Klemm 2010: 14-5), the Gisr el-Mudir (350 m west) and the substructure assigned to Hotepsekhemwy, the founder of Saqqara, immediately south. It is unclear how visible Hotepsekhemwy's RMC would have been, since little remains of the surface structures (see Chapters 2 and 9). As mentioned in Chapter 2, Djoser's RMC was built over earlier structures, one of which Stadelmann (1985) argues may have been a substructure that belonged to Khasekhemwy. The structure is 1.8 km south of the entrance to the Wadi Abusir. Another small wadi 850 m southeast of his RMC, which was later used for Unas' causeway (last 5th dynasty king; see Appendix A), was also probably used to access his RMC. The complex is about 1 km from the presumed location of the OK capital and 1.8 km due west of the river, and canals connect it to a perennial lake at the mouth of the Wadi Abusir. The desert surface here is uneven and the bedrock is a marly limestone, moderate in quality.

The RMC, built mostly with limestone, has the most complex design of all preserved ED and OK RMCs (figs. 7.2.a,b). Though largely completed, certain sections remain unfinished, especially in the northern sector. Vyse and Perring (1940), and Lepsius (1849-1856) visited the site, but Lauer (1935-6; 1936-9) provides the bulk of the information about the complex in his reports. The RMC consists of a monumental, north-south limestone enclosure surrounded by a dry, rock-cut moat. As with the Gisr el-Mudir, the east wall is on a plinth (Mathieson *et al.* 1997). As with the Abydos mudbrick enclosures, the enclosure wall was decorated with the palace-faced motif (fig. 7.3; Lauer 1962a: 110) and accessed from the southeast corner, through an entrance colonnade (figs. 7.4-7.5). Inside were structures used for the king's living (*Heb-Sed*) and mortuary rituals, and dummy ones for the dead king's ka, or soul (Lauer 1988). The tomb is for the first time placed in the centre of the enclosure. South of the tomb is a court with two ritual cairns, an altar and a small southern tomb for the king's ka. To the east is temple T, a *Heb-Sed* court (fig. 7.7) and two pavilions representing Upper and Lower Egypt (fig. 7.8) and to the north a temple, serdab (sealed room with a statue of the king), courtyard and magazines north and west (fig. 7.2.a). The substructure consists of a vast system of galleries, pits and chambers cut deeply into the bedrock, in a manner similar to the earlier 2nd dynasty royal substructures, but more complex. These may be divided into two groups: the first, accessed from the north, corresponds to the king's royal apartments; the second, to the east, consists of a series of earlier funerary pits and tunnels that were reused for the burial of royal children (Lauer 1962a: 71-5). Six distinct construction stages, most visible in the superstructure, provide a useful temporal framework for the work, and curiously echo in number those of Khasekhemwy's substructure at Abydos. Depending on the length of Djoser's reign, the different architectural phases could correspond to a change every three years (Lehner 1997: 84). However, the first two stages (M1-M2) likely belonged to an earlier ruler (Lauer 1985: 64-5; Stadelmann 1985; Tavares 1993). The following section reviews the building stages with an emphasis on the superstructure.

The first two mastaba stages (M1-M2), the first burial chamber, the north, south and east galleries under M1-M2, the initial north altar, and the magazines near the north and west appear to be of an earlier date to Djoser's reign (Stadelmann 1985; Tavares 1993: 1137). While the identity of the owner remains unknown (Lauer 1985: 64-5; Stadelmann 1985; Tavares 1993), Stadelmann (1996: 798) argues that the western galleries that are aligned with Hotepsekhemwy's galleries, but much larger, belonged to a tomb Khasekhemwy would have had at Saqqara. Perhaps M1-M2 was his too.

The initial mastaba, which represents 23,500 m^3 of material (Lauer 1936a: 12), shows a mix of stone and earthen approaches to building. Unconventionally, it has a square base (63 x 63 x 8 m) and differs from the two later building stages in that the construction stone is grey limestone. The blocks are 0.30 m high and laid in horizontal courses, as those of the Gisr el-Mudir, and coated with two thick layers of mud-mortar (Lauer 1962a: 69). The fine limestone casing blocks (2.6 m thick), which are carved with a batter, are slightly dressed. The top of the mastaba was slightly rounded, or bevelled, and probably made with rammed earth (Lauer 1936a: 13). M1 was built around a large, central square shaft (28 x 7 m) at the bottom of which was the initial burial chamber. The quantity of travertine fragments showing dressed sides, more often than not, suggest that travertine lined the walls of the first burial chamber (Quibell and Firth

1935: 62 (n.1), 93; Lauer 1936: 32). The floors were paved with small blocks of anorthosite gneiss. The ceiling was made with limestone blocks carved with five pointed stars the upper and lower sides (Firth and Quibell 1935: 20; Lauer 1962a: 74-5) Perhaps the blocks were to capture the light from the sky and transfer it to the burial chamber (Firth and Quibell 1935: 29, 46, 56). A rock-cut stairway connected multiple corridors to 400 storerooms. Unique to this RMC are blue faience tiles found in three rooms, and in one case six panels with depictions of royal rituals (Lauer 1962a: 77-82). The eastern galleries, some of which were cut to avoid the central shaft, were used for burials of the royal family and to store thousands of stone vessels, many of which were reused from earlier reigns (fig. 7.9; Lacau et Lauer 1959: 29-38; Lauer 1962a: 82-98; Roth 1993: 48, fn. 49). The second building stage (M2), representing 2,900 m^3 of limestone, is part of the initial mastaba and consists of adding a 'double-casing' (8.5 m thick), a common practice in 1st-4th dynasty mastabas (Lauer 1936a: 14). It was formed of fine limestone blocks (0.28 x 0.30 m), this time laid on a foundation course and articulated like the M1 casing; the corner blocks have a 3 cm wide chamfer to avoid a weak arris, something unique to this monument (Lauer 1936a: 14). The top of M2 is significantly lower (0.65 m) than M1, creating a decorative step that may also have served to collect runoff from the mud roof after rainfalls. Altogether, the construction displays considerable skill (Lauer 1962a: 70).

The third stage M3, definitely attributable to Djoser, transforms the square mastaba into a rectangular one by extending M2 to the east, giving the structure an east-west axis (vs the traditional north-south axis). The masonry, laid on a foundation course, is made of a yellowish limestone that differs from the earliest phase, and bound with thick mortar. However, for the first time, the courses are laid in accretion layers, a method retained for all subsequent stepped-pyramids (Lauer 1962a: 70-2). The casing, laid in the same way as with M1-M2, also partially dressed and with flattened corner arrises, was incomplete, with the north face left undressed (Lauer 1936: 15). The superstructure covered the entrance to the eastern galleries, although the galleries could still be accessed from the top of M3; uninscribed stone stelae marked the entrances. A foundation deposit, since destroyed, was laid under the south wall of M3 (Lauer 1936a: 15-6, 1962: 71). The enclosure probably dates to this stage, and, half its final size was of a dimension comparable to Khasekhemwy's at Abydos (Kaiser 1969). The entrance colonnade, South tomb, and the *Heb Sed*, north and south pavilions were all built in limestone, but buried almost immediately, possibly as a symbol of life after death (Stadelmann 1996).

The fourth stage P1 transformed the mastaba into a rectangular-based four-step pyramid (163 x 147 cubits). Larger and better-articulated blocks of the same yellowish limestone as M3 were used but with less mortar (fig. 7.10). The fine limestone casing blocks (0.35 cm high) were cemented by a thin coat of mortar and laid to form a batter. The construction of P1 was quickly abandoned; the north face was only brought up to only 8 courses (2.5 m; see Lauer 1962a: 71-2). The North Temple (42 x 13 cubit), made of small blocks of limestone and cased with fine limestone (3.5 m thick), may be an expansion of an earlier temple associated with M1-M2 (Lauer 1936a: 17). The new burial chamber (1.65 x 2.96 x 1.65 m) dates to this expansion and is entirely lined with granite. The walls were formed with five courses of well-articulated and well-dressed granite blocks (4 m high), the ceiling of nine blocks of granite (3.80 m long, 1.05 thick and between 0.45 - 0.80 m wide) and a granite plug weighing c. 3.5 tons sealed the room. None of the granite is weight-relieving (El-Naggar 2005: 431). The south tomb was modified to be a smaller replica of the new tomb. The enclosure wall, of a similar height (10.5 m) to Khasekhemwy's enclosures at Abydos and Hierakonpolis, was probably brought to its final size during this stage. Conversely to the mudbrick enclosures, the 1,680 recesses that form the 9 m tall niches of the palace-façade were all hand-carved out of the fine casing blocks (2.30-4.70 m thick) after the blocks were positioned rather than made by laying the blocks, representing a tremendous task (Lauer 1936: 84). The complex was expanded to the north but never finished (Lauer 1988: 8).

The fifth stage P' (200 x 225 cubits) extended the pyramid to the north, covering the temple. Six steps formed of two accretion layers (10-11 cubits thick) were intended, but the design was abandoned after four (fig. 7.11; Lauer 1936a: 21). The fine limestone casing (5-8 cubits thick) wall was abandoned on the west wall after 4.70 m.

The sixth and final building stage P2 added two other steps to the north face with casing half a step thick (5 cubit); the casing of the south and east walls was 8.5 cubit. The casing is made of very well articulated and slightly larger blocks (0.48-0.52 m high) than were used in the previous stages, bringing the pyramid to its final dimension (121 x 109.2 x c.60 m; Lauer 1936a: 23-4).

Material Characterisation

Soft limestone is the most conspicuous construction material used for Djoser's RMC, with the final superstructure alone requiring c. 330,400 m^3 (see table 8.1.). The two varieties of soft limestone used, a grey one for M1-M2 and a yellow for the final four stages, both from the Maadi formation of the Middle Eocene Ravine Beds, were available locally and are moderate in quality, ranging in texture from a sandy limestone to a calcareous sandstone (Klemm and Klemm 2010: 14-5). The soft limestone's moderate quality means quarrying left few traces at Saqqara, making the quarries hard to locate. Recent petrographic evidence has confirmed that the cliffs were the main source of limestone, something already hinted at by their jagged appearance, the heaps of quarry rubble at their base and the worked outcrops in their vicinity (Klemm and Klemm 2010: 14-5). The dry-moat trenches around Djoser's complex and the small wadi that connects the southeast corner of Djoser's RMC to the valley, used later for Unas' causeway, likely served as a quarry and construction ramp (Klemm and Klemm 2010: 13). Earlier quarries near the Gisr el-Mudir and ED-OK quarries 4 km west may also have provided some material (Aston *et al.* 1994; Mathieson *et al.* 1997), as well as reused material from earlier structures (fig. 7.13). Conveniently, the stone at Saqqara is available in slabs 20-60 cm thick separated by layers of calcareous marl, providing (a) readily available, ready-made sheets that only needed to be cut and (b) material for the mortar (fig. 7.12). The limestone's poor quality facilitated quarrying and dressing, but lowered its resistance to weathering, which likely prompted the use of a harder, more resistant limestone for casing (Klemm and Klemm 2008: 55-6). The softness of the stone and proximity of the source, combined with the likely reuse of earlier structures and material, kept certain logistical costs to a minimum, possibly giving more time to specialists to shape the blocks finely for Djoser's building activities and do the fine work, a very slow process.

The fine limestone used in Djoser's RMC is also from the Maadi formation. It is only recently that petrographic analysis determined that the fine limestone used in RMCs prior to the 4th dynasty did not come from the Tura Maasara quarries widely used from the 4th dynasty onwards, but actually came from a west bank source each time cut by the RMC building site. It is more compact than the Tura-Maasara variety, and when polished, more resistant to weathering (Klemm and Klemm 2010: 14-6). Because the stone was depleted by the early 4th dynasty, the stone's exact source is unknown. However, the presence of many fine fragments on the plateau suggests limestone was sourced from small local deposits, or came from further afield and dressed on site (Klemm and Klemm 2010: 14-6). Copper tools were quickly damaged by the harder varieties of limestone, which could therefore only be quarried using stone tools (Stocks 1986: 25-5; Arnold 1991: 32; Aston *et al.* 2000: 15).

With an estimated 97,000 m^3, granite is the most conspicuous hard stone consumed in Djoser's complex. It is estimated that 55% (53,500 m^3) was used to line the walls and ceiling of Djoser's burial chamber and 45% (42,600 m^3) that of his south tomb. The size of the units, 3,8 m maximum length, weighing between 5-8 tons and representing a volume of 2,500-3,500 m^3 each (Lauer 1962a: 26) suggests that they were quarried rather than collected as boulders, as was possible with Khasekhemwy and Den's granite units (see Chapters 2 and 6; fig. 7.14). Röder (1965: 483-4) argues that the final, finished units represent only 30-40% of the total mass of stone transported, enough left to cushion the block against accidental damage (Arnold 1991: 52), and offer maximum flexibility to the stonemason depending on what the block would be used for in the complex. At the site, the blocks were dressed in a manner that depended on the stone's placement and use in the complex. One of the main tasks consisted of flattening the joining sides before placement within the monument. This was done on the ground in order to ensure a perfect accord between two abutting blocks. Good knowledge of stone masonry and geometry was necessary to dress the stone most effectively. After dressing and placing the blocks in the monument, all that was left to do was to polish the visible surfaces. This final finishing touch was one of the simplest yet most time-consuming tasks and detrimental to the health of its practitioners because the quartz dust can cause lung damage when inhaled (Stocks 2003: 237). Apprentices or even unskilled workers could easily have carried out this activity (Bevan 2007: 53). The fact that the granite used for the walls of the dummy burial chamber was covered in green copper oxide (Lehner 1997: 92) indicates that smoothing was likely carried out with copper tools.

Although it is hard to determine the spatial layout of quarrying activities at Aswan, as ongoing quarrying has removed all traces, the granite probably came from the two main quarries that are attested in the archaeological record and provided the best quality granite and conditions for transport. One is 1 km south of Aswan, where the unfinished NK obelisk is located; the other further inland is at the eastern end of the plateau (Ball 1907: 74-5; Aston 1994: 16). Although it is uncertain, it is possible that the spatial targeting of work was similar for the ED/OK granite quarries to that observed at the OK gneiss quarries discussed below. The blocks were likely transported by land over a maximum distance of 2 km to the river, then 700 km downstream, then overland to the Djoser's RMC possibly via the small wadi later used for Unas' causeway (Kelany *et al.* 2009: 18). Transport of large units was likely limited to the summer months when the inundation provided enough excess water to pass the cataract at Aswan (Kelany *et al.* 2009: 18). There is no evidence for shelters or dwelling at Aswan, which suggests that the workers lived in permanent settlements nearby, probably on the island of Elephantine and/or at Aswan (Kelany *et al.* 2009: 8-9). It is possible that a non-specialist workforce, such as the excess labour that would have been available for two to three months prior to the harvest and during the summer inundation, could perform the more labour-intensive and time-consuming tasks, such as the quarrying and polishing. However, given the unique working properties of granite, the knowledge required for adequate treatment of granite strongly points to a specialist workforce, particularly for dressing, as it is done when the stone is most fragile (Arnold 1991: 39). A moving specialist workforce may have been used, as a certain amount of processing took place at the building site. Djoser's granite consumption represents a considerable amount of work compared to earlier uses of granite in Den's tomb at Abydos or Khasekhemwy's enclosure at Hierakonpolis. More work was entailed even when compared to the use of anorthosite gneiss in Djoser's first burial chamber. Anorthosite gneiss is a hard stone comparable to granite, and it came from a distant quarry but a comparatively low quantity was used.

Anorthosite gneiss, which was traditionally used for stone vessels, was used for the first and only recorded time architecturally for the monument's first burial chamber in the main tomb and the south tomb. Although the gneiss used for the first burial chamber is probably not attributable to Djoser, a brief review of the logistics surrounding its consumption is provided here. In addition to being one of the hardest stones, anorthosite gneiss came from a remote quarry situated 800 km south in the Nubian Desert (fig. 7.14), making it a very valuable material especially in architecture (where it cannot be re-circulated). The main gneiss quarry, known as 'Chephren's Quarry', is in the easternmost part of the Sahara and extreme south of Egypt, 15 km west of Gebel el-Asr and 120 km south of Wadi Tushka. The quarry area, which covers 28 km^2 of flat, hyper-arid desert was exploited from the Late Predynastic to the 12th Dynasty. The gneiss occurs as large and small inclusions in Precambrian granitic outcrops. The younger rocks erode, leaving openings for the older rock, resulting in a highly irregular outcrop pattern and causing a similarly uneven and scattered distribution of quarries (Heldal 2007; Bloxam 2009: 9).

The OK North Quarries (the Cairn Quarry, Quartz Ridge and Pounder Quarries) were exploited mostly for smaller units of lighter anorthosite gneiss used principally for stone vessel production and are the ones likely to have been targeted for the pavement in Djoser's RMC (Storemyr *et al.* 2002: 26). The Cairn Quarry had a roughly circular layout, with a central area c.100 m in diameter that reflects a highly organised production. Waste was discarded in orderly piles at the edges to leave the work area clear. Work on single or small boulders was carried out at smaller satellite quarries. No large quarries were identified. The stone was probably extracted using the most common OK hard stone quarrying method consisting of rough-shaping loose boulders with pounders. Despite being a highly cohesive rock, diorite gneiss is also rich in feldspar, which is a crystalline mineral that splits in certain directions when struck, a process known as cleavage. The gneiss can be broken using pounders, and with the advantage that the rock will not fracture (Bevan 2007: 41). This process leaves heaps of waste-rock around the space where the blocks were extracted. There is also evidence for deep digging in the larger quarries (Engleback 1938: 371), where quarry workers most likely exploited open fissures, or cracks (Storemyr *et al.* 2002: 27). The deep excavation requires removing the weathered stone. Charcoal chips found around the sand-filled depressions left by the removed boulder indicate that fire-setting was used to a certain extent, to get to the core stone and split boulders (Murray 1939: 108; Storemyr *et al.* 2002: 27; Bloxam *et al.* 2007). Using pounders, the split boulders were roughly shaped into homogeneous blocks for small vessels and larger statuary. There is no evidence of final shaping of smaller units at the site. Vessels or the small units used for the initial burial chamber in Djoser's complex were probably finished at a specialist workshop after transportation from the extraction site (Storemyr *et al.* 2002: 26).

Evidence from an 80 km cleared track to Tushka that probably dates to the Middle Kingdom may have already been in use during the OK (Murray 1939). It appears to terminate near what could have been an embarkation point near a large camp with large heaps of stone marked with flags 3 km from Tushka. The location was strategic as during the inundation, the wadi brought water 10 km inland at least and the road leading to it was downhill, altogether facilitating transport (Harell 2002: 236-8). It is possible that other roads were used, such as the caravan route that connected Egypt and Sudan just west of the quarries. From the Tushka camp, the gneiss would have been loaded on boats and sailed to the workshops and/or RMC building sites 800 km north, benefiting from the downstream current. The cataract that made the transportation of granite and granodiorite from Aswan seasonal most likely also affected the transportation of gneiss too, as Tushka is located 200 km upstream from the second cataract (Murray 1939; Shaw and Bloxam 1999: 16). The layout at the quarries and the infrastructure in place suggests a highly organised and skilled workforce for the 4th dynasty at least, but one that may already have been in place for earlier periods. It remains unclear whether a more permanent trade and vessel-production existed (Bloxam *et al.* 2007). There is no evidence for permanent settlements in the area. Rather, workers huts, complete with bakery and wells, were located 200m south of Quartz Ridge, dated to the 3rd - 5th dynasty based on pottery. These could have accommodated approximately 20 people. Altogether, the evidence indicates short-lived but highly organised campaigns set up for specific purposes (Storemyr *et al.* 2002: 25). This type of organisation is very different from that evidenced for travertine during in the Old Kingdom at Hatnub (Shaw 1986; Shaw and Bloxam 1999: 17).

For the first time, travertine was used for architectural purposes in an RMC to line the initial burial chamber in Djoser's RMC. Travertine, which is at the limit (Moh's scale 3) of the informal distinctions made between soft and hard stones, has similar working properties to the harder limestone varieties; it cannot be carved with a blade or punch, and modern experiments indicate that a copper chisel cannot easily cut into the material, as the tool's edges wear rapidly (Stocks 2003: 64-9). Although this may not be considered an acceptable loss of metal in modern terms, copper chisels can still cut the stone, but will require frequent re-sharpening (Stocks 1986b: 26). Travertine provides a very interesting finish, in that it can be finely polished to a point of reflecting light. Polishing is a simple but time-consuming task that is often delegated to unskilled workers. The stone also has aesthetically pleasing qualities such as distinctively coloured bands and semi-transparency. Combined with its greasy texture, which makes it impermeable, travertine was most commonly used for stone vessel production, but also funerary furniture such as altars that received libations (Shaw 2010: 6). Travertine does not require the sophisticated tools and organisation that the consumption of hard stone, such as granite (see below), requires.

Travertine occurs as filled-in cracks and caves in Eocene limestone. Eight out of the nine known quarries are located on the eastern bank of the valley; only two are considered as potential sources for the OK. Based on the available archaeological evidence – and 17 inscriptions dated to the OK, the earliest of which dates to the reign of Khufu (4th dynasty) – the main OK travertine quarry was 300 km upstream from Saqqara, at Hatnub, which means the 'house of Gold', probably derived from the stone's colour and luminescence (fig. 7.14a; Shaw 2010: 6). It remains unclear whether or not the quarry was used in the 3rd dynasty. Given the widespread use of the material for the ED, however, and the importance of this quarry in the OK, the quarry remains are reviewed here.

At Hatnub, a road dated to the mid-3rd millennium BC leads to the quarry and branches out to smaller quarries (Aston 1994: 45). The main quarry is a large open pit 50 x 80 m and 25-30 m deep and accessed from the north by a long, narrow rock-cut path 100 m long whose gentle slope facilitated the transport of material. The quarry was covered; its roof has since collapsed (Klemm and Klemm 2008: 162). There is no evidence that large units were worked at the quarry site. Stone blanks suggest that vessels were roughed out here and finished in a workshop elsewhere. Perhaps the same applies to larger units (Shaw 2010: 21). If the OK settlement was used for sleeping, then the size of the rooms points to groups of workmen organised in multiples of three. The evidence points to widely dispersed structures that lack any communal area, as well as "centralised administration and organisation" (Shaw 2010: 21.). It remains unclear whether a single quarrying community or several different communities carried out the work (Shaw 2010: 73).

The organisation of the Hatnub travertine quarry is similar to the gneiss ones at Gebel el-Asr, the basalt ones in the Fayum, and the other travertine quarry at Wadi Gewarri discussed later in this thesis (Bloxam and Storemyr 2002; Bloxam *et al.* 2009). Wadi Gewarri was the other important OK travertine quarry that is much closer to Saqqara and hence may have been the one used for Djoser's RMC (25 km). Although it is unclear if the quarry was used in the 3rd dynasty, given the proximity of this quarry to Saqqara, the evidence is reviewed here.

The main quarry area is located just 4-6 km upstream from an OK dam (built with limestone blocks and a rubble core) that traverses the wadi in its entirety. The pottery scattered along the track that links the dam to the quarry and found associated with the workmen's huts dates to the OK (Petrie and Mackay 1915: 39; Schweinfurth 1922: 213-31; Erman 1971: 470; Aston 1994: 45; Aston 1994: 44-5; Shaw 2010: 20). The quarry consists of fissure-filled deposits with the travertine occurring as vertical bands 2-3 m wide. The first outcrop, 4 km east of the damn, has been entirely quarried away. The vein crops out again 2 km further up, where the wadi branches out and the vein runs parallel to the wadi, forming a cliff and steps where it has been quarried (Aston 1994: 45). A road connects the quarry to the valley. Fourteen dry-stone workmen's huts were built beside the dam. Some are very large (1,000 m^2) and may have served as barracks for about 200 men (Shaw 2010: 20). Their location by the dam led some to think that the dam was built to supply the workers with rainwater collected in the wadi after rainstorms or to prevent flash floods from destroying an important structure west of it (Schweinfurth 1922: 213-31; Aston 1994: 44-5; Shaw 2010: 20). Not excluding any of these, it may also have been used to transport blocks to the Nile with mud paths (Fahlbusch 1986; Klemm and Klemm 2008: 148). As with the Tura-Maasara quarries exploited later in the 4th dynasty, the travertine deposits at Wadi Gewarri may also have been connected to hot springs (Schweinfurth 1922; Aston 1994: 44; Aston *et al.* 2000: 59-60; Harrell 2007: 422-3; Storemyr *et al.* 2008). The stones exhibit many similarities. Both The Hatnub and Wadi Gewarri quarries are 15-20 km east from the cultivation. Quarrying and transportation of travertine was something that could be achieved all year around.

Although their original position remains uncertain, three basalt paving blocks were found in Djoser's burial shaft (Firth and Quibell 1935: 62 (n.1), 93). Although this remains speculative, based on later uses, basalt may have been used in the north temple as pavement or wall lining (Aston *et al.* 2000: 24). Unfortunately, Firth and Quibell (1935: 62 (n.1), 93) did not record dimensions or other details that could help shed light on the processing of the stone or inform us concerning the logistics surrounding the acquisition and consumption of the material. Still, these blocks could potentially be the first recorded use of basalt in architecture, and although this may be down to chance of preservation, basalt, like granite, is not used again for another 60 years until Khufu's RMC. Depending on the total volume of stone required and the individual size of the units, the stone could have been transported from the Gebel Qatrani quarries north of the Fayum by water or land, as was the case later when basalt is used in RMCs (see section 8.2). Or basalt could have been collected from small boulders in the vein running from Abu Rawash to the west of Saqqara (fig. 7.12). The uncertainty surrounding the use of basalt in Djoser's RMC means that a much fuller treatment of basalt is given later in Section 8.2, in relation to Khufu's RMC.

7.2. Sekhemkhet

Sekhemkhet, Djoser's immediate successor, also built his RMC at Saqqara. Aside from his RMC and the Turin Papyrus assigning Djoser's successor 6 years of reign, nothing is known about this king (Seidlmayer 2006). In 1951, the Egyptian archaeologist M. Z. Goneim discovered the complex, which he named the Buried Pyramid, and carried out partial excavations between 1951 and 1954, providing the sole two reports (Goneim 1956, 1957) for the complex. In addition, Maragioglio and Rinaldi's survey (1963) and Lauer's (1967a, 1968) work at the site provide useful information that offers insight into the strategy behind Sekhemkhet's complex. Although the construction of Sekhemkhet's RMC was abandoned at an early stage, probably as a result of his premature death, and its building materials were quarried for reuse in later periods, available evidence indicates that Djoser's architect Imhotep oversaw the construction of Sekhemkhet's RMC. Such evidence is derived from the fact that Sekhemkhet's RMC largely followed the design of Djoser's, the main differences being that Sekhemkhet's enclosure was narrower, probably due to local geomorphology, and the intended pyramid was to be larger than Djoser's. Sekhemkhet's RMC shows remarkable expertise and care in execution, and a maturing in craftsmanship (Goneim 1956, 1957 pl. 13; Lauer 1967a).

Location and Layout

In keeping with his immediate predecessor Djoser and the wider 2nd dynasty royal funerary tradition, Sekhemkhet built his RMC at Saqqara between Djoser's RMC (200 m northeast) and the Gisr el-Mudir (90 m east). Although his RMC is set slightly further (830 m) into the desert and from the Wadi Abusir lake and entrance (2 km), it is much closer (90 m) to the small wadi southwest of Djoser's RMC (see tables 9.1, 9.3; fig. 7.15). The wide spatial relationships, such as to the capital or river, are identical to Djoser's. To avoid repetition, please refer to section 7.1. Although the geology is similar to Djoser's (moderate quality limestone from the Maadi formation) the ground is uneven and shows a mixture of marked elevations and depressions (Goneim 1957: 4; Maragioglio and Rinaldi 1963: 12). A narrow and steep north-south running ridge west of the RMC likely determined the enclosure's slightly offset orientation compared to Djoser's (11°30' west of north).

As mentioned, the overall layout of Sekhemkhet's complex is similar to Djoser's, but with fewer associated structures, probably due to its unfinished state. The complex consists of the partial remains of a limestone enclosure wall, a pyramid in its centre, a south tomb, the scant remains of a temple, and a raised terrace to the north. In parts, the pyramid was built on a raised masonry platform to make up for the uneven nature of the terrain. This provided stability and also increased the height and visibility of the pyramid, possibly to make up for the fact that it was slightly set back into the desert from Djoser's. The pyramid was only brought up to the enclosure height (7 m). The substructure was roughly completed, but not finished (Goneim 1956, 1957).

The north terrace (349 x 194 m), which is rock-cut to the east, consists of a battered, retaining masonry wall (21 m thick) the inside of which was packed with rubble (Maragioglio and Rinaldi 1963: 13). The builders employed the same greyish limestone used for Djoser's M1-M2 phases. Despite its poor state of preservation - only a few courses remain, the enclosure, which was started after the terrace, is remarkably well built and was extended 200 m to the north, despite being unfinished. The masonry blocks are much bigger than Djoser's (0.50-0.52 m high courses vs 0.24-0.26 cm) and well laid in regular courses, making the walls stronger and pointing to the builders' confidence (Clarke and Engelbach 1952: 163). It is not clear from reports if the blocks were squared or not. The fine limestone casing, though much thinner (0.30-0.35 cm) than Djoser's, was also carved, though still awaiting the *in situ* carving of its false doors (fig. 7.16-17). Large, well-squared and well-dressed blocks, like those of Djoser's enclosure wall, were used for the enclosure's outer face. The evidence indicates that the blocks were dressed *in situ* with copper chisels and regular strokes. The fact that flint crescents' traces are absent from the undressed faces suggests that copper chisels had replaced flint for the dressing and quarrying. The blocks were cemented with gypsum plaster fired at a proper temperature, which is interesting for a 3rd dynasty structure as it shows a high level of expertise (Goneim 1957: 36). Quarry and masons' marks as well as levelling lines and workmen's drawings painted in red ochre and drawn in black charcoal are visible on undressed wall surfaces (Goneim 1957: 2-4).

The superstructure (120 x 120 m) consisted of 14 inward-inclined accretion layers (each 2.60 m thick), now only 7 m high. The height of the building ramps indicate that the structure was originally higher, but once abandoned, blocks were removed and reused elsewhere (Goneim 1957: 11). The masonry blocks are as big as those used for Djoser's final stages, but poorly squared and undressed. The courses are levelled and parallel, and as with mudbrick masonry, the blocks alternate between headers and stretchers.

They are bound with mortar (coarse *tafl* and crushed limestone gypsum) and the bedding joints are wider than the rising ones. Corner stones were used. There is no trace of casing (Goneim 1957: 11). Although unfinished, the execution of the larger superstructure intended was more accomplished than Djoser's, and a single effort from the start. However, it did require more foundation work than Djoser's. Little is known of the temple north of the pyramid, of which only blocks remain. Of the south tomb, only a few foundation courses remain, enough to indicate that it may have been a limestone mastaba rather than a step pyramid (Lauer 1968).

The tomb substructure at abandonment was further advanced in construction than the superstructures and shows better craftsmanship than Djoser's. Also consisting of a vast network of subterranean galleries, it follows a well-defined plan (fig. 7. 16). The ground-level entrance is perfectly aligned with the pyramid's central axis, the entrance corridor leads to a beautifully executed rock-cut archway (1.05 x 3.90 m), unique in Egyptian architecture, and sections of walls were plastered, probably to make up for the poor geology (Maragioglio and Rinaldi 1963: 21). A U-shaped gallery-system, with ventilation shafts at both ends and 132 magazines, embraces the base of the pyramid from the north. A shaft smaller than Djoser's (2.70 x 12.60 m) was cut to remove debris from the substructure's excavation (Goneim 1957: 11-3). The eastern ventilation shaft comes out under the east wall of the enclosure, showing that the enclosure was built *after* the substructure was completed, giving some indication of the order in which the RMC was built. The burial chamber, right under the centre of the pyramid, is larger (8.90 x 5.22 x 4.55 m) and deeper (32 m) than Djoser's (28 m). Cut in poor quality bedrock, it is very damaged; wall sections were repaired with masonry blocks and remained unfinished, and the floor was littered with construction debris (Goneim 1957: 18-20). A sealed but empty sarcophagus made of a single block of travertine was found inside. Sekhemkhet's substructure shows remarkable craftsmanship in execution and overall design compared to Djoser's; building was much more systematic and shows unique features. Skills in quarrying, stone-cutting, crafting and masonry seem to have been perfected. However the bedrock into which the foundations and substructure were cut was much poorer in quality than further east on the plateau, where Djoser built his tomb. This meant that the repairs, although they show care, did not guard the building against collapse.

Material Characterisation

As with Djoser's RMC, soft limestone is the main material used (see table 8.1.). Two types of soft limestone were identified in the pyramid core. One, more common, is very light grey-beige and dense, with occasional fine layering similar to Djoser's M1-M2 limestone. The second, less common, is a yellow-brown sandy limestone that tends towards sandstone. Both types are local. Yet the two varieties suggest that two separate outcrops were targeted, with a clear preference for the better quality, denser variety. Given the abandonment of the structure, an extensive quarry cannot be expected, but the workers were most likely targeting limestone outcrops near the south-west corner of the RMC (Klemm and Klemm 2010: 27). Given the bedrock's poor quality, the material removed for the substructure was probably not used for building (Goneim 1957: 18-20). The fine limestone used for the enclosure casing is a light grey-beige, very fine grained and compact limestone. Although less white than Djoser's, the two limestones have the same geochemical signature and show similarity with that of the North Saqqara Quarries. Both stone's sources are likely to be on the plateau near Djoser and Sekhemkhet's RMCs (Klemm and Klemm 2010: 28-30).

Although not architectural, the sarcophagus is worth mentioning. It had a unique sliding door mechanism to open it at one of its ends and was made out of single block (2.35 x 1.13 x 1.05 m) of yellowish-white veined travertine (Klemm and Klemm 2010: 27). The inside of the sarcophagus (1.84 x 0.60 x 0.62 m) was hollowed out leaving chevron-shaped saw marks. Three corners were damaged during transport, but repaired perhaps *in situ* with patches of travertine glued with pink gypsum plaster. The corners damaged in transport indicate that the sarcophagus was crafted prior to its placement, perhaps at the quarry. The exterior is polished; the interior remained unpolished. Tool marks indicate that the workers used flint and tools that made conical grooves. The sarcophagus lay on clay, which perhaps was used to facilitate transport (Goneim 1957: 19). The practice is reminiscent of the mud paths suggested to have been used to transport stone from the Hatnub and Wadi Gerrawi travertine quarries (Klemm and Klemm 2008: 148). Although there are no inscriptions to support this attribution, nor large units left in the Hatnub quarries to indicate that they were working there, the sheer size of the block suggests that the travertine likely came from the more distant Hatnub Quarries (245 km south). Most large travertine units are from Hatnub rather than the much closer Wadi Gerrawi ones 25 km due east from Saqqara (Shaw 2010: 16).

That which remains of Sekhemkhet's RMC exhibits a high degree of craftsmanship. However, the poor quality bedrock and lack of space at Saqqara may have contributed significantly to his likely successor moving the royal necropolis a few kilometres north to a site with almost identical affordances.

7.3. Khaba

The unfinished Layer Pyramid at Zawyet el-Aryan (fig. 7.21-7.24) is commonly ascribed to Khaba, Sekhemkhet's presumed successor (see Chapter 2). Vyse and Perring (1840), Lepsius (1848), Maspero (1885) and De Morgan (1886) give brief descriptions of the pyramid, while Barsanti (1901), Reisner and Fischer (1911) carried out more detailed excavations. However, their plans show discrepancies in the layout, dimension and number of storerooms (Dodson 2000: 81). Although these discrepancies do not affect the present discussion, our understanding of the RMC remains limited, especially given its ruined state, state of incompletion, and the fact that the complex lies at the edge of a military camp, compromising current re-investigation (Klemm and Klemm 2010: 33). All that remains to date is the ruined tomb and about 300 private tombs from the ED, late 3rd dynasty, NK and the Roman period.

Apart from the pyramid, there are no traces of the rest of the complex (Lehner 1996: 510) and the local topography suggests that the monumental enclosure that characterises the RMCs at Saqqara was never planned. This is an interesting departure that, perhaps unintentionally, along with systematic site change, set a trend that was continued throughout the OK (Lehner 1996: 510). Lehner (1996: 511-22) convincingly disproves Swelim's (1983: 78-96) argument, that the mastaba (Z500) 220 m north of the pyramid was the north temple reused as a tomb, on the basis of the tomb's architecture and content. Traces of mudbrick walls east of the pyramid may be the remains of an eastern cult chapel or mastabas. Traces of mudbrick and stone further east may be those of a valley temple. If this could be verified, it would be significant as it would make it the earliest valley temple (Swelim 1983: 77; Klemm and Klemm 2001: 34). As we shall see, valley temples are not attested until the 4th dynasty (Chapter 8). The claim that a causeway must have existed because the desert surface was scraped away in front of the pyramid (Perring 1837: 10) is uncertain as the area was heavily quarried and a 23 %

slope is problematic for a causeway (Dodson 2000: 87; Maragioglio and Rinaldi 1963: 45). The evidence for a causeway therefore remains inconclusive.

Location and Layout

Despite its poor state of preservation, Khaba's RMC shares many similarities in shape, layout, construction materials and methods and location with those of his two immediate predecessors' at Saqqara. Khaba left Saqqara to build his RMC 9 km north at Zawyet el-Aryan. From here, Djoser's tomb was visible to the south as was Sekhemkhet's and the capital (10 km). As with the Saqqara RMCs, Khaba's is located southwest of ED mudbrick tombs also built along the edge of the escarpment (see tables 9.1, 9.3; Lehner 1996: 514). Late 3rd dynasty tombs are also in the vicinity. That they are the most prestigious ones of all private tombs at Zawyet el-Aryan further supports a late 3rd dynasty date for the Layer Pyramid (Reisner 1911: 59). Although a high cliff (16 m) separates the RMC from the valley, as at Saqqara (17 m), the RMC is much closer to the edge of the escarpment than Djoser's and Sekhemkhet's (110 m vs 750-830 m; see tables 9.1, 9.3). The bedrock, though slightly better quality than at Saqqara (Klemm and Klemm 2010), remains moderate to poor and the topography did not allow for a vast enclosure as at Saqqara (Reisner 1991: 56; Lehner 1996: 510). In a similar way to Saqqara (Djoser's dry moat and the Gisr el-Mudir's eastern plinth), quarrying activities reshaped the local setting, by levelling and lowering the desert surface in parts and by bringing the edge of the eastern escarpment closer, making the RMC stand out in the local landscape (Klemm and Klemm 2010: 34-5). The conditions of access are very similar to that seen at Saqqara with a potential local access route potentially 60 m southwest of the pyramid (Maragioglio and Rinaldi 1963: 45), and a broader wadi situated 600 m northwest of the RMC with a similar gradient and location to the Wadi Abusir at Saqqara (Lehner 1996: 510). Following a natural ridge, the complex is orientated 8-9° west of north, as with Sekhemkhet's (Lehner 1996: 510).

The superstructure is a smaller version of the step pyramids at Saqqara. It measures 84 x 84 m at its base and would have reached up to 45 m (Djoser 121 x 109 x 60 m; Sekhemkhet 120 x 120 x 70 m intended) had it been completed and not enlarged, as was customary. Khaba's pyramid is built in the same fashion as Sekhemkhet's and Djoser's final stage, with inward leaning accretion layers made of blocks of local limestone slightly larger than his predecessors' and cemented with thick mortar. The internal apartment that Barsanti found completely empty was also rock-cut and has a layout that is almost identical to Sekhemkhet's. The main difference lies in the entrance approach that runs east-west before turning 90 degrees towards the centre of the pyramid, most likely to have facilitated the furnishing of the storerooms. This constituted a logistical solution to a problem that the builders first faced with Sekhemkhet's substructure at Saqqara. If the entrance approach is straightened, the design is a simplified version of Sekhemkhet's (Dodson 2000: 87). The substructure was modified four times, each time with a desire to deepen the burial chamber, potentially to increase the sub- and superstructure's stability (Dodson 200: 86) in response to the relatively poor geology. The first stage was a shallow shaft that leads directly to the burial chamber with storerooms on the same plane. The second phase moved everything deeper, with the BC placed close to the centre of the pyramid. A new access ramp was also cut and the storerooms to the north started. Stage three shows another deepening of the BC and, during the fourth and final stage, the storerooms were completed and stairs were cut along the access descent to facilitate movement of goods and possibly building materials (Dodson 2000: 84-86).

Material Characterisation

Limestone, the main building material, is sharp edged sandy and fossil-rich (see table 8.1.; Klemm and Klemm 2010: 34). From a local source, its quality is comparable to Saqqara's (Klemm and Klemm 2010: 34). Two varieties are available and both were employed in the construction of the pyramid. As at Saqqara, the limestone is stratified (Maragioglio and Rinaldi 1963: 42) and therefore conveniently comes in ready-to-cut sheets. The lower stratum limestone is soft and olive green to brownish, and the upper one, 1-1.5 m thick, is harder and brownish. As at Saqqara, the height of the blocks used in the pyramid is the most consistent feature (0.15-0.20 m). However, the height is slightly less than at Saqqara, probably due to the thickness of the sheets, but the blocks are cut longer (Klemm and Klemm 2010: 34). The outer faces are roughly squared and, because the limestone came in sheets, the workmen only had the vertical faces roughly dressed. As in mudbrick architecture, the blocks are laid in alternating courses of headers and stretchers (Maragioglio and Rinaldi 1963: 42). A quarry was located 150-200 m east and north of the RMC (Klemm and Klemm 2010: 34) and a depression 20 m south-west of the pyramid, now in the military zone, is another potential quarry (Lehner 1996: 510). The mortar, used in thick coats and mostly in the horizontal joins, is made of *tafl*, which probably was derived from the excavation of the substructure (Maragioglio and Rinaldi 1963: 42). Although in part determined by the nature of the source, features are similar to the two earlier Saqqara RMCs of Djoser and Sekhemkhet, and mudbrick architecture (Reisner 1911: 56; Maragioglio and Rinaldi 1963: 42). These are: the blocks reflect narrow widths, consistent height, heavy reliance on mortar, especially for horizontal joins, as well as the way in which the blocks are laid.

There is no evidence to suggest that fine limestone was used for casing or lining. However, the possibility that casing was intended and/or the stone subsequently robbed should not be excluded. If the remains of mudbrick mentioned earlier are indeed associated with the RMC rather than the mastabas, then mudbrick may also have been employed. Runoff from the thick *tafl* mortar led Reisner (1911) to believe erroneously that the pyramid was cased with Nile silt (Maragioglio and Rinaldi 1963: 44). Reisner (1911: 54) mentions a granite lining for the cross-cut pit and burial chamber. However, as granite is not mentioned in other reports, and Reisner's description of the substructure's layout seems to fit the description of the unfinished pyramid known as the Great Pit 2 km north (section 8.5), this comment should be treated cautiously.

7.4. Unassigned Mudbrick Structure at Abu Rawash

As mentioned in Chapter 2, a mudbrick structure located south of the modern village of Abu Rawash has been tentatively dated to the end of the 3rd dynasty (fig. 7.25-7.32; Swelim 1987a: 3, 80-7). Except for a simple T-shape substructure cut in a rock-knoll, very little remains of the structure today. The rough execution of the internal structure suggests that the RMC was left unfinished, at quite an early stage (Swelim 1987a: 42). The structure's proximity to the cultivation and settlement area would have made it an easy target for reuse. Reuse would reduce chances of knowing whether a wider complex had been intended and started, or what layout was intended, which could have helped to further date the structure. This and the fact that the structure was never excavated limits our knowledge to a single preliminary study Swelim carried out in 1987, and early explorers' short, often unsystematic and erroneous descriptions, though Lepsius (1987) provides us with useful depictions and maps (Vyse and Perring 1840: 193-4; Bisson de la Roque 1924). Although the exact date and ownership of this structure remain unconfirmed, the pottery evidence points to the 3rd dynasty. It has a 4th dynasty design, the layout of its west bank location, its position north of the capital, layout of its internal apartment, the height of the entrance, the use of a rock-knoll and large dimension. The

4th dynasty chronology and tomb ascription is well established. Indications are that it may be one of the missing RMCs of the late 3rd dynasty, potentially belonging to Kings Neferka or Huni, both attested in the contemporary inscriptional evidence of the period, but for which no RMCs have been successfully identified (Swelim 1987a: 3, 80-7).

The Abu Rawash mudbrick structure is often confused with another similarly poorly preserved mudbrick structure known as Ed-Deir (the convent) north of the village of Abu Rawash, also built around a rock-knoll, yet not one that was reworked (Macrammallah 1932). Pottery evidence also dates it to the 3rd dynasty (Swelim 1987a: 38). While Swelim (1987a: 38) believes it was an OK RMC, the lack of internal apartments refutes this idea, as the internal apartment is one of the first elements undertaken when building an RMC. Instead, the date, design, dimension, material choice and location, of the Ed-Deir structure means it shares many traits with the series of minor step pyramids built across Egypt during the 3rd dynasty, and to which I return in Chapter 9. Although dating and ascription are tentative, the view offered here is that the Abu Rawash structure is potentially an unfinished RMC of the later 3rd dynasty.

Location and Layout

The chosen location near the modern village of Abu Rawash marks the northern limit of the OK pyramid field. It is 14 km and 22 km north of Zawyet el-Aryan and the capital respectively. The structure, breaking with the Saqqara tradition, is on the edge of the floodplain at cultivation level (25 m ASL) and would have been part of the Delta environment. It is built right below (30 m) a local private ED and OK mastaba cemetery that lies to the west (170 m) and south of the closest main wadi (300 m) and at about 2 km west of the Nile (see tables 9.1, 9.3). The tomb is built 300 m away from the rising escarpment further west, which forms an impressive backdrop. The highest point would have been at least 150 m, which is the highest recorded elevation for OK RMCs in this region. In finished form, the superstructure would probably have been slightly higher than the ED and OK tombs, and its placement at the entrance of the small wadi, leading to the two private cemeteries, meant it was encountered prior to reaching the private cemeteries (Swelim 1987a: 20).

It is difficult to infer much information regarding material use from the remains and survey. The main materials used were naturally occurring rock-cut limestone and mudbrick. No traces of fine limestone for casing, such as with MK pyramids, or mud-plaster remain. In 1842, the superstructure still stood to about 16 m with its north side presenting the only straight masonry wall, the base of which was at least 32 m (Swelim 1987a: 12, 47). Based on Lepsius' (1849: 66) measurements of the structure and mudbrick masonry wall remains, the base of the structure may have measured 215 x 215 m, making it potentially the largest OK pyramid. The limestone knoll represented about one fourth of the superstructure (150 x 65-100 x 25 m). It was artificially exposed and roughly levelled into terraces, ramps, trenches, steps and slopes to support the mudbrick masonry, though some of the limestone knoll was of a later date. The limestone bedrock east of the structure was also levelled to receive the mudbrick masonry. Though this cannot be confirmed, the arrangement of these reworkings suggests that the masonry was formed by accretion layers 1.6-3.6 m thick, likely placing the monument in the 3rd dynasty (Swelim 1987a: 22-48). The square base and likely accretion layers would point to a step-pyramid ranging in height between 107.5-150.5 m and with an incline between 68°-76° (or 45°-55° if a perfect pyramid; Swelim1987a: 69). These dimensions make it comparable to the later pyramid of Khufu at Giza and the largest of all known MK mudbrick pyramids. However, that another type of superstructure was built, such as a large, square mastaba, should not be excluded (Swelim1987a: 59). The internal apartment was T-shaped. The entrance (3.5 x 5.5 m), which is 6 m above ground and was cut from the centre of the 2nd central terrace and the burial chamber, is the only well-cut feature of the structure (Swelim 1987a: 26-9). A squared corridor slightly larger than in subsequent pyramids (1.8 m vs 1.1 m) c.20 m long with a 25° incline leads to the burial chamber at the centre of the superstructure, 2 m lower than the corridor. The burial chamber is almost a cube (5.5 x 5.5 x 5.0 m) and well executed, despite the fact that the workers had to deal with both good and poor quality limestone (Swelim 1987a: 39).

Material Characterisation

The limestone at Abu Rawash is of much higher quality than limestone from sites further south, where lie all other known RMCs (Klemm and Klemm 2010: 102). However, the knoll in question varies in quality, showing alternating layers of what Swelim (1987a: 39) describes as good and poorer quality limestone. The use of limestone at the site, which involved cutting the exterior and interior of the rock knoll, would have been less demanding on the workforce than at previous RMCs. Although it is impossible to estimate the amount that was removed from the exterior of the knoll, approximately 215 m^3 of limestone was removed from the interior. Shaping the knoll to enhance the stability of the mudbrick masonry involved some degree of planning and design. The execution in parts shows good craftsmanship. It is unknown whether or not blocks of limestone were used for masonry in other parts of the intended complex and extracted from reworking the knoll.

Regarding the mudbrick used, not much may be inferred, as by 1923 all the bricks had disappeared (Swelim 1987a: 12). Early reports describe them as well-made, without any straw and ranging in size from 30.5 x 15.5 x 9.5 cm to 49 x 25 x 19 cm (Swelim 1987a: 14), which is larger than those used for Khasekhemwy's structures, but comparable to the bricks used in private OK cemeteries, such as at Giza, and for the later MK pyramid (Spencer 1979: 25-39). It is assumed that the brick, which represented one fourth of the total superstructure's masonry mass, would have been manufactured locally with readily available material.

7.5. Unassigned Stage E0 at Meydum

The RMC at Meydum is generally ascribed to king Snefru, who carried out most of the work at the site (fig. 1.1; 7.33-34). However, as discussed in Chapter 2, the pyramid was built in three distinct phases (E0, E1-E2 and E3), each corresponding to a completed monument and discrete building phase. As mentioned in Chapter 2 (section 2.4), the view taken here is that the distinct construction phases of the pyramid E0 and E1-2 and E3, and their two respective causeways, point to two potential ownerships, and that Huni, who is generally considered the last king of the 3rd dynasty and Snefru's immediate predecessor, may be responsible for E0 and the initial causeway. However, that another unknown ruler of the 3rd dynasty may have been responsible for E0 should not be ruled out. This section focuses on the initial structure E0 only; stages E1-2 and E3 are reviewed in the following section on Snefru's RMCs (section 8.1). Very little remains of the complex apart from the pyramid itself, which, since its casing collapsed in antiquity now stands as a two-step structure. Information on E0 is limited due to its position at the core of the pyramid. Although Stadelmann (1980) does not consider E0 in his discussions of the monument, his and other reports, and discussions provided by Petrie and colleagues (1892, 1913), Lauer (1967) and Maragioglio and Rinaldi (1964) provide useful insights for understanding the monument and its different phases.

Very little is known about Huni. Huni ordered the construction of a palace at Egypt's southern border on the island of Elephantine (Kaiser and Dreyer 1980; Kaiser 1998a,b) and is most likely responsible for a series of minor step pyramids built across Egypt (Dreyer 1980; Ćwiek 1998), which appear to act as cultic, redistribution centres and markers of royal presence in key centres across Egypt (see Chapter 9; Pochan 1937; Ricke 1950; Lauer 1967b; Fakhry 1969; Swelim 1987ab; Lesko 1988; Para Ortiz 1996; Ćwiek 1997, 1998).

Location and Layout

The Meydum E0 pyramid is 75 km south of Abu Rawash and 54 km south of the capital. Located in Middle Egypt, it stands out as separate from the tighter OK pyramid-field (figs. 7.33, 7.34, 7.35). If the chronology of monuments proposed here is correct, then the move to middle Egypt is the most significant of the OK after the shift to Saqqara from Abydos. Yet, as discussed in Chapter 9, it may make more sense when considered in light of the unassigned mudbrick structure at Abu Rawash. At the time of construction, Djoser's RMC, visible on a clear day, would have been the closest RMC, 54 km north at Saqqara. Though less conspicuous, the closest royal structure would have been the Seila pyramid 13 km to the west. While the Meydum pyramid is further from the edge of the cultivation than the Abu Rawash structure (350 m), it shares a low-lying position (17 m above the valley floor), making it the lowest desert-based OK RMC (see tables 9.1, 9.3). The Meydum pyramid stands in a remarkably flat area that contrasts with the high ridges at Abu Rawash. Meydum marks a point in the landscape where Lower and Middle Egypt meet, each respectively characterised by a narrow and wide valley system and the Fayum to the west. The RMC would have been about 6 km from the river, which is further away than any of its earlier counterparts. Like Abu Rawash, the closet large wadi is 300 m away.

The evidence suggests that the initial complex consisted of a step pyramid (E0) and causeway. An eastern cult area, satellite pyramid, enclosure and valley temple may have existed and later been reused when Snefru returned to the complex and incorporated most of the existing features. The pyramid and causeway indicate that the initial complex already consisted of an upper section at the edge of the desert and a lower section near the cultivation.

The causeway is very well executed, which excludes its use as a construction ramp, as Borchardt (1928) had initially proposed (fig. 7.36; Petrie *et al.* 1910: 7). It is rock-cut, at times to a depth of 2.5 m, and forms an almost perfect east-west axis (760 m long, 4 m wide). Its narrow walls (0.22 m), which are coated in plaster, and floor are built of mudbrick. Lines at the bottom of the walls suggest that the floor was going to be paved, perhaps with slabs of limestone, potentially masking the mudbrick (Petrie *et al.* 1910: 7). The difference between this causeway and the previous one is too slight to explain abandonment on logistical grounds. Rather, the desire to rebuild in stone and in a way that achieved greater symmetry with the whole complex is more likely.

E0, which came to form the nucleus of Snefru's final pyramid, is a three-step pyramid consisting of a central core with two compact masonry accretion layers built around it with a square base of 52.8 m, or 100 cubits (Petrie *et al*. 1892: 5-9; Lauer 1967b: 241, note 4 p. 241; Maragioglio and Rinaldi 1964: 10-2, 36). Unfortunately the original height cannot be determined. The masonry consists of a simple infill of limestone blocks cased with hard dressed limestone blocks. It is unclear if the core blocks were dressed (Maragioglio and Rinaldi 1964: 12). The design of the internal layout of E0 is unknown. However, it may not have been so different from the final pyramid, given that the substructures were the first components built and the inward inclined masonry would have exerted too much pressure to allow modification. Interestingly, the internal apartments follow a plan similar to Abu Rawash. However, rather than created using the rock-cut gallery method of Saqqara, Zawyet el-Aryan or Abu Rawash, the builders used the open-trench technique, which is reminiscent of the royal mudbrick substructures at Abydos, and most later RMCs. The technique consisted of a north descending corridor leading to a small chamber roofed with heavy beams of limestone masonry, from which a shaft led up to the north-south oriented burial chamber (5.9 x 2.7 m) 6 m underground, and with a corbelled ceiling formed of limestone beams lodged in nooks cut in the bedrock for better support. No stone sarcophagus, or trace of one, was found in the burial chamber (Maragioglio and Rinaldi 1964: 40-4). Altogether, the substructure shows good craftsmanship and innovation in masonry technique, especially for ceilings, and the open-trench rock-cut technique, bridging two traditions, possibly due to the poorer quality bedrock. Table 7.1 gives volume estimates for phase E0 at Meydum.

Building Phase	*Masonry Volume m^3*	*Masonry Percentage*	*Masonry Quality*	*Casing Volume m^3*	*Casing Percentage*	*Casing Quality*	*Source*
E0	156,000 ?	85 %	good+ poor	22,500	15 %	excellent	local

Table 7.1. Estimates of volume of masonry for stage E0 of Meydum pyramid (author's calculations from Maragioglio and Rinaldi 1964)

Material Characterisation

The limestone used for E0 has not been sufficiently well documented to be certain of its origin. Yet, we do know that both a soft and hard variety were used, and that both were available on site (see Section 8.1.2; Klemm and Klemm 2010). Although the height of E0 is unknown, based on Djoser's tomb superstructure at Saqqara which shows similar dimensions, a rough estimate of 156,000 m^3 of limestone consumed can be proposed.

7.6. Summary

To summarise, kings Djoser and Sekhemkhet both had their RMCs built at Saqqara near the administrative capital, very much in keeping with the 2nd dynasty tradition established by Hotepsekhemwy (see Chapter 2). The scale of their RMCs' superstructures (fully realised for Djoser, anticipated but unfinished for Sekhemkhet), and use of shaped blocks of soft and fine limestone differ from previous RMCs, especially that which is visible with Djoser's RMC. The likely reuse of structures and/or construction materials, in Djoser's case at least, the presence of the Gisr el-Mudir and its likely late 2nd dynasty date, and Sekhemkhet's choice of a site with uneven topography and poor bedrock are all interesting features returned to in Chapter 9. It is also noteworthy that Sekhemkhet's likely successor, Khaba, departed from the trend of building either at Abydos or Saqqara. After Hotepsekhemwy and his move from Abydos to Saqqara, Khaba was the second king to reject the use of the established royal cemetery. Khaba instigates systematic site-change, with his RMC marking a significant shift from the centre-marking tradition of his forbearers at Abydos and Saqqara to one in which each king after him starts a new royal necropolis in the Memphite region in the north of Egypt. The locational patterns of Khaba's RMCs are noteworthy when considered in conjunction with the setting, materials, and construction method of the

Saqqara RMCs and the features it shares with them, a topic to which I return in Chapter 9. Although the succession of rulers and sequence of construction for the latter part of the 3rd dynasty is blurry, if the regnal attributions and monument ascriptions offered in this thesis (Chapter 2) are close to correct, the locational and material pattern of the two likely subsequent RMCs at Abu Rawash and the Meydum (E0) suggest a change in location of RMCs from Abu Rawash to Meydum. Such a shift is possibly the most significant of any during the period considered here. It takes royal building activity far from the capital, into Middle Egypt. The Meydum phase E0 and the unassigned mudbrick structure at Abu Rawash may shed more light onto this poorly understood period especially when considered in the context of other contemporary structures known as the Minor Step Pyramids (MSPs; fig. 7.37).

CHAPTER 8
SNEFRU TO SHEPSESKAF

This chapter provides a chronological site-by-site analysis of the locational and material parameters for the nine RMCs known for the 4th dynasty, the period after Huni's reign. As discussed in Chapter 4, while there is still some debate regarding the succession of kings towards the end of the dynasty, the chronology is much better established than it is for the 3rd dynasty, as are the tomb ascriptions. Based on the evidence reviewed in Chapter 4, the sequence proposed here starts with Snefru's three monuments at Meydum and Dahshur, followed by Khufu's RMC at Giza, Djedefre's at Abu Rawash, Khafre's at Giza, the unassigned RMC known as the Great Pit at Zawyet el-Aryan, here ascribed to Nebka, Menkaure's RMC at Giza and Shepseskaf's at South Saqqara.

8.1. Snefru

In later tradition Snefru was considered the founder of the 4th dynasty (2,650 BC). As discussed in Chapter 2, Snefru had three RMCs - the three southernmost OK RMCs - and the view taken here is that he reused the tomb of a predecessor at Meydum and built two RMCs c.45 km north at Dahshur. When Snefru founded Dahshur in his 15th regnal year, two royal buildings were consecrated 'Snefru high of the white crown' and 'Snefru high of the red crown' (Hawass 2006: 20). Though it is unclear what structures they refer to, they stress sovereignty over Upper and Lower Egypt. Snefru introduced the royal cemetery next to the royal tomb, for family and followers. This practice differed from 1st and 3rd dynasty practices in which cemeteries were placed at a distance from the royal tomb (Roth 1993). Both his sons, Ra-hotep, chief-priest of Heliopolis and overseer of the army, and Nefer-ma'at, vizier and architect, who started an unbroken line of viziers that lasted throughout the OK, were both buried at Meydum (Bolshakov 1991). Evidence suggests that Snefru may be the son of Huni and his secondary wife Mersy-ankh, and that he married his half-sister Hetep-heres, who is buried at Giza near their son Khufu's pyramid (Hawass 2006: 14).

When Snefru came to power, the natural boundaries of Egypt were secured and both trade and manpower were well developed, something that he further promoted (16). There are records (Palermo Stone, carved reliefs) of raids into Nubia and Lybia (13th and 18th regnal year) and possibly in Sinaï, which provided 18,000 prisoners and 213,000 cattle. Snefru opened anorthosite gneiss quarries in Nubia and ordered the building of ships with cedar from Lebanon, enabling large-scale trade on both river and sea. The cedar wood from Lebanon was also used for Snefru's royal palace and inside his Bent pyramid at Dahshur (Hawass 2006: 19). With war and trade, Snefru insured the acquisition of resources for royal estates, the earliest evidence of which comes from his valley temple at Dahshur, suggesting that Snefru potentially created the estates to help with his royal building projects. In the 12th dynasty Snefru was deified and MK papyri (Tale of Neferti and Westcar Papyrus) indicate that by then he was remembered as a benevolent ruler. NK graffiti in the mortuary temple at Meydum indicate that a pilgrimage to his funerary cult site still took place in the NK (Hawass 2006: 20).

Snefru is renowned for his unparalleled consumption of limestone, estimated 3.5 million m^3, or 40% of that consumed for the entire 4th dynasty (Stadelmann 1980). The view taken here is that Snefru's architect aggrandised an earlier pyramid at Meydum (E0; see section 7.5; Lauer 1967b; Maragioglio and Rinaldi 1964: 1). This first effort took place during the first 15 years of Snefru's reign into the stages known as E1 and E2. Then in his 15th regnal year, Snefru moved to Dahshur to start a new necropolis for unknown reasons where he built the Bent pyramid. In the last 15 years of Snefru's reign, when the North Pyramid was built he sent workers to Meydum to transform the pyramid into a perfect one, known as E3, which collapsed shortly after being built in antiquity (figs. 8.1.1, 8.1.2, 8.1.3; Stadelmann 1980). This section deals with stages E1, E2 and E3. The view taken here is that Snefru also oversaw the aggrandisement of a Minor Step Pyramid 10 km west of Meydum, at Seila (Pochan 1937; Lauer 1962b; Dreyer and Kaiser 1980; Swelim 1987b; Lesko 1988; Cwiek 1997, 1998). The Seila MSP is not covered in this chapter but I return to discuss it in Chapter 9.

8.1.1. Meydum

The Meydum RMC is traditionally seen as setting the east-west layout maintained in all subsequent RMCs until the end of the OK. The complex consists of two separate sections: an upper part at the edge of the desert with pyramid and a chapel to the east; and a small satellite pyramid to the south surrounded by a perimeter wall. This upper portion was linked by means of a causeway to the lower part of the complex, at the edge of the cultivation, which consisted of a valley temple. Today, only the pyramid E1-2 is visible. Vyse and Perring (1840) carried out brief investigations, as did Maspero in 1882. Petrie and colleagues (1892, 1910), Borchardt and Croon (1928), Rowe (1931) and El-Khouli (1991) oversaw systematic excavations. Maragioglio and Rinaldi (1964), Lauer (1967b) and Stadelmann (1980, 1983) provide valuable observations for understanding the RMC's phases.

Location and Layout

Please refer to section 7.5 and tables 9.2 and 9.4 for the RMC's locational setting. While the pyramid shows distinct building stages, it is not clear to which stages the RMC's different architectural features belong. Yet, the evidence suggests that the satellite pyramid, perimeter wall, causeway and valley temple belong to the Pyramid's stages E1 and E2, and the eastern chapel to the pyramid's final casing stage E3. Although tentative, the following section follows this order to set the building stages in better temporal context.

In the first 15 years of Snefru's reign, his architect converted the initial three-step pyramid E0 into a much larger one. This required clearing and levelling the desert surface and building four accretion layers around E0, transforming the original pyramid E0 into a seven-step pyramid (E1); another layer was added, making E1 into an eight-step pyramid (E2). The limestone blocks are laid in battered courses, which is typical of earlier 3rd dynasty RMCs. A harder limestone variety is used for the casing. Rather than E1 and E2 being two separate construction phases, the fact that they are bonded together and built with the same construction methods and materials indicates that they were one project intended to create a double-casing, as with Djoser's M1-2 mastaba and mastabas of the first four dynasties, including a number of early 4th dynasty ones at Meydum (Lauer 1967b: 241-2). Hence they are hereafter referred to as E1-2. That the building method of E1-2 is characteristic of the 3rd dynasty likely confirms that the building took place before the two Dahshur pyramids were built, as the latter's construction method more closely resembles Snefru's successor Khufu's at Giza (Maragioglio and Rinaldi 1964: 7). The east chapel abutting the pyramid belongs to the last building stage of the pyramid reviewed below (E3), yet it is likely that a similar structure existed for the earlier stages. No traces survived so I cannot comment on it further.

Very little remains of the satellite pyramid (26.65 x 26.65 m) built near the southwest corner of the main pyramid. As with E1-2, it was built on a foundation of three courses of inward inclined limestone blocks. This type of foundation and the satellite pyramid's proximity to the final pyramid (5 m from E3) strongly suggest that the satellite pyramid was built during the first phase E1-2 and that it was probably a small stepped pyramid (Maragioglio and Rinaldi 1965: 26, 46). Of the interior, only two monumental blocks of well-dressed limestone remain (Maragioglio and Rinaldi 1965: 26, 46). The limestone perimeter wall (walls 1.45 m thick and 2.0 m high), which is completely destroyed but for a few remaining foundation courses, was rectangular with an east-west orientation. The pyramid is off-centre; more space was left to the north, probably to incorporate the mastaba to the northeast. The surrounding courtyard was unpaved. A mudbrick path led from the eastern chapel to the end of the causeway (Petrie *et al.* 1892: 7).

The limestone causeway (210 m long, 1.45 m wide), which was never finished, is just a few meters north of the first causeway, and almost perpendicular to and centred on the axis of the pyramid. Sections were rock cut, at times to a depth of 2.0 m. The walls (2.0 m high and 1.6-1.9 m thick) have a batter and bevelled tops (Petrie *et al.* 1892: 7). The floor is made of a thick (8 cm) coat of mud-plaster (Maragioglio and Rinaldi 1964: 28). Very little remains and little is known of the valley temple, which is now under the cultivation. A small mudbrick wall extends (8.5 m east) from the causeway and joins a north-south running wall; the foundations of a retaining mudbrick wall, running north-south (for at least 90 m) from the causeway entrance, may have acted as a boundary between the cemetery and cultivation. Fragments of pink granite and travertine in the area were likely the remains of foundation deposits (OK pottery jars; Petrie *et al.* 1910: 2; Maragioglio and Rinaldi 1964: 30-2).

In the last 15 years of Snefru's reign, building resumed at Meydum with his architect attempting to convert the stepped structure into a perfect pyramid by filling the gaps between the steps with limestone blocks. The foundations, which consist of three courses of limestone blocks laid directly on the sand, are poor in comparison to E1-2. This time, the masonry and casing blocks were laid horizontally in the 4th dynasty manner (Klemm and Klemm 2010: 40). The eastern chapel, built entirely with fine limestone, most likely belonged to the final phase E3. It abuts the final pyramid and covers a much larger area than the two at Dahshur, which brings it in line with the trend in OK mortuary temples which show a constant increase in size over time. The chapel consists of a corridor, open-court and inner sanctuary with two uninscribed, rounded-top limestone stelae. It was completed but not finished (Petrie *et al.* 1892: 8), and is characterised by very regular masonry courses and outer faces with a slight inward batter. Only the external north and south sides were dressed. The inner court is paved with undressed slabs of limestone and the corridor and inner sanctuary have mud floors.

Material Characterisation

Limestone was the most conspicuously used material on site. Soft limestone was used for the masonry of the pyramid, satellite pyramid, perimeter wall, and causeway (see table 8.1). Fine limestone was used to case the pyramid, for the entirety of the chapel and at least the interior of the satellite pyramid. Table 8.1 gives rough estimates of the volume of masonry and casing employed for the pyramid's phases E0, E1-2 and E3 and shows that E0, which represents the bulk of the masonry, is likely associated with an earlier owner. Alternatively, if the estimate is too generous, the stages represent comparable volumes of limestone.

Building Phase	*Masonry Volume m^3*	*Masonry Percentage*	*Masonry Quality*	*Casing Volume m^3*	*Casing Percentage*	*Casing Quality*	*Source*
E0	156,000 ?	85 %	good+ poor	22,500	15 %	excellent ?	local
E1	116,000 ?	64 %	good+ poor	42,000	36 %	excellent	local
E2	105,500	50 %	good+ poor	53,000	50 %	excellent	local
E3	258,000	70 %	good + poor	80,500	30 %	poor	local + distant

Table. 8.1. Estimates of volume of masonry and casing employed for phases E0 and E1-2 of Meydum pyramid (author's calculations from Maragioglio and Rinaldi 1964)

In keeping with the 3rd dynasty tradition, the builders used locally available limestones. Both soft and hard come from the same slightly marly geological unit. The main soft limestone quarry is 1 km south of the pyramid, at the desert edge, with a few small outcrops encircling a heavily worked quarry still visible; as at Saqqara, the outcrops closer to the pyramid are likely to have been targeted. Another possible quarry area is situated 600 m due south of the pyramid (Klemm and Klemm 2010: 41-4). The softer limestone, which is yellowish-brown, is of a relatively poor quality, and its tendency to laminate causes it to weather easily.

Two varieties of fine limestone were used for the E3 pyramid's casing (Klemm and Klemm 2010: 39). A slightly harder variety, which is greyish-white, very fine and densely textured, and extremely weather-resistant comes from the same geological unit as the fine limestone layers used further north at Saqqara; it is of superior quality when compared to the Tura-Maasara variety used for the majority of later OK RMCs (Klemm and Klemm 2010: 41-4). Being depleted, its source could not be determined. At some point, as a consequence of depletion, workers for the first time had to turn to the less weather-resistant, off-site variety from the Tura-Maasara stretch east of the capital (Klemm and Klemm 2010: 60). The petrographic analysis of the limestone indicates that it came from a gallery quarry at the southern end of the Tura-Maasara stretch, at Maasara. This is one of the southernmost areas of Tura-Maasara and meant that 20-40,000 m^3, or metric tons, of limestone had to be transported 60 km up-stream to Meydum. For gallery quarries, the process of extraction consists of removing the poorer quality limestone, cutting steps into the stone face, excavating a long corridor into the bedrock, cutting down into the limestone behind the first step and digging deeper into the bedrock, forming a gallery (Aston *et al.* 2000: 6). Copper tools were instantly destroyed by the harder varieties of limestones, which could therefore only be quarried using stone tools (Stocks 1986b: 25-9; Arnold 1991: 257-68; Aston *et al.* 2000: 15; Bevan 2007: 55). The dust, lack of light and restriction on movement in gallery quarries made the task much greater than in open quarries (Arnold 1991: 31-2; Aston *et al.* 2000: 6).

Evidence from the Tura-Maasara quarries shows that the blocks were moved on specially built ramps using rollers or wooden sledges, probably as early as the OK; a block of the size of those used for RMCs was found on a ramp (Charlton 1978: 128). Similar systems are attested at the hard stone quarry of Gebel el-Asr in Nubia and the building sites of Giza, South Saqqara and North Dahshur, indicating that this moving method was also used at building sites. A wide depression in front of the Tura quarries may have been a dock used to load boats throughout the year, even during the inundation. It is impossible to determine whether a loading basin existed in front of each quarry (Klemm and Klemm 2008: 52). Later in time, the 5th dynasty tomb inscription of Senedjemib, royal architect and builder buried at Giza, states that it took five days to bring his limestone sarcophagus from Tura - the northern area of the Tura-Maasara stretch, representing c.24 km downstream - to Giza. The 6th dynasty Saqqara papyrus refers to a barge for stone between Tura and South Saqqara (Eyre 1987: 15). The stones to referred to were probably dressed after transportation, once they had reached the building site, but they would have to have been dressed rapidly or else the stone would dry, significantly increasing its hardness. The blocks destined for the underground foundation or core masonry would have been left as they arrived. A copper sheet-saw may have been used to enable the perfect fit many pyramid blocks display (Arnold 1991: 42-4; Aston *et al*. 2000: 15). There is no evidence of a workmen's settlement near the Tura-Maasara stretch; given the capital's proximity to the Tura-Maasara stretch, perhaps the workers were based at the capital, although this remains speculative.

Masons' marks were found on fallen blocks of both soft and fine limestone from the pyramid's northeast corner. The inscription on filling stones and backing blocks are generally (1) a phyle name, or (2) a sign used to define a phyle, (3) quarrymen's or masons' section, or (4) signs that were made either at the quarry or on the building site, though the exact context is now lost. There is only occasionally a date. Snefru's name appeared nowhere on the blocks studied (Posener-Kriéger 1991: 17-8). Only the *wr* phyle is mentioned at Meydum (Petrie *et al.* 1910: 7-9; Posener-Kriéger 1991: 17-8). However, two inscriptions may be phonetic readings of the *stj* phyle (Roth 1991: 125). Inscriptions on fine limestone painted on the rough sloping face of the casing block, i.e. pre-dressing, record the date the block was placed. As mentioned in Chapter 2, years 16, 17 and 18 'of the cattle count' correspond to regnal years 30-31, 32-33 and 34-35 of Snefru's reign. The highest potential date corresponds to years 45-46, which is also the highest at Dahshur North (Posener-Kriéger 1991: 19). Hence, the dates coincide with the building of Snefru's North Pyramid at Dahshur (see section 8.1.3), showing that the workforce was divided between two sites 45 km apart, and both upstream from the source of harder limestone they were employing at Maasara.

8.1.2. Bent Pyramid

Snefru's south pyramid at Dahshur is more commonly known as the Bent pyramid because of its double-angled slope. The pyramid itself is relatively well preserved and the valley temple is the oldest preserved. Vyse and Perring (1840), Lepsius (1842), Petrie (1888), Jéquier (1924) and Hussein and colleagues (1945) carried out brief investigations. Fakhry and colleagues (1954, 1959, 1961) provide the most detailed excavation reports, which, combined with Maragioglio and Rinaldi's (1964) survey, provide the bulk of the published information used in this section. Different parts of the RMC were modified over time both during and after Snefru's reign; only the original design and first modifications contemporary with Snefru's reign are dealt with here.

Location and Layout

Snefru's South Pyramid is 45 km north of Meydum and 9 km south of the capital and the royal cemetery at Saqqara (fig. 2.17; 8.2.1-8.2.4). On a clear day, Djoser's RMC at Saqqara would have been visible. The site is at a higher elevation (50 m ASL) than Meydum, causing the desert edge escarpment to seem more pronounced than at Meydum, something it shares with the RMCs built nearer the capital (see table 9.3, 9.4.). Yet, the Bent Pyramid that is set back the most (1,600 m) from the desert edge, at least among the pyramids built up to this time. The closest large wadi is 1,800 m to the northeast and the river is estimated to have been approximately 6 km to the west (Jeffreys 2008: 5). Yet, a seasonal lake, which still exists at the foot of the escarpment, may have been a perennial feature. Although the Bent Pyramid is the second southern-most RMC after Meydum, the location suggests a preference for a location south of the capital, but one closer to the capital than Meydum, something returned to in Chapter 9. The karstic bedrock, of moderate to poor quality, is clay-rich karsts and covered by a thin layer of sand and flints with compacted clay (*tafl*) (Maragioglio and Rinaldi 1965: 56; Klemm and Klemm 2010: 48). The builders were unaware of the instability the karsts caused until it was too late, as discussed below (Klemm and Klemm 2010: 68), which suggests that the quality may have seemed adequate at the start.

The Bent Pyramid RMC has the same layout as the Meydum one and is also built with limestone. Yet, when the pyramid had reached c.29 m, the pyramid's incline angle was lessened from c.59 to 54.31º and its base broadened to make the pyramid more stable; the angle was changed again when the pyramid was 49 m in favour of an even less obtuse one (43º 40’; Fakhry 1959: 40). Some argue that the change in angle reflects a desire to complete the pyramid hurriedly (Vyse and Perring 1840), others that it was planned from the start, as the root of Snefru’s name, *sn,* means two and many features of the pyramid are doubled, including the angle (Varille 1947). However, evidence indicates that the double angle is more likely to be a response to bedrock subsidence. Reducing the degree of incline reduced the weight of the masonry, potentially avoiding further subsidence (Maragioglio and Rinaldi 1964: 92; Klemm and Klemm 2010: 38). The pyramid (188.6 x 188.6 m, 101.5 m high) has two internal apartments connected by a tunnel. Whereas the lower apartment entered from the north is mostly rock-cut, except for part of the entrance corridor that is built with masonry, the upper apartment entered from the west is mostly above ground and made with masonry. While soft limestone is used throughout, the floor of the lower apartment’s second antechamber is paved with fine limestone. Seven cedar beams in the burial chamber were likely used to move material (Fakhry 1959: 47-59). The pyramid’s masonry and casing show a mixture of 3rd and 4th dynasty construction methods. The masonry consists of blocks of local limestone laid inclined toward the centre, though slightly less than the 3rd dynasty manner calls for. The blocks are 1.52 m long on average, have a systematic height (0.60 m) but vary in depth (maximum 2.0 m). The upper portion is poorly executed compared to the lower portion (Maragioglio and Rinaldi 1965: 58). The casing is made of smoothed, fine limestone laid slightly inclined and shows a similar pattern to the core masonry. While the lower blocks are of excellent quality and very large (maximum 1.85 m), the upper blocks are smaller and poorer in quality (Fakhry 1959: 40). The casing rests on foundations made of inward-sloping limestone blocks. A special emphasis was placed on the pyramid’s corners, with deeper foundations creating more stability (Maragioglio and Rinaldi 1965: 56). Altogether, the lower part of the pyramid is better built with better materials than the upper section (Vyse and Perring 1940: 66; Maragioglio and Rinaldi 1965: 58).

The eastern chapel initially consisted of a court paved with limestone, in the centre of which stood a limestone offering table formed by three superimposed slabs of limestone carved into the shape of the *htp* sign (word for offering), with a slab of travertine inserted to receive offerings (Maragioglio and Rinaldi 1965: 72). The table was flanked with two 9 m tall limestone stelae with depictions of the king in a *Sed* robe, wearing the double crown of Egypt, a layout reminiscent of the early 1st dynasty chapels at Abydos (Fakhry 1959: 98). The stelae were erected first in the rough and secured in deep foundations made of limestone blocks, and later smoothed and carved *in situ*. Either during, or right after, Snefru's reign, a small chamber was built around the offering table, in part employing reused limestone blocks and mudbrick for two walls (1.5 m high) with bevelled tops extending east, probably to protect the altar from sanding (Maragioglio and Rinaldi 1965: 72). Another cult structure, of which almost nothing remains, was located at the centre of the pyramid's north face. Wall foundations made of unsquared blocks of fine limestone defined an area of 6 x 5 m around a pit that narrows as it deepens, lined with unsquared blocks of limestone. A mudbrick structure, consisting of a platform and walls, and a limestone offering table were later added, perhaps contemporaneously, to the east chapel's second phase. Remains of travertine, calcite, diorite and cedar were found (Fakhry 1959: 41-6; Maragioglio and Rinaldi 1965: 80).

The southern pyramid (52.80 x 52.80 m) with its eastern chapel and two limestone stelae with Snefru's name is a smaller, simplified version of the main pyramid. The masonry is formed of horizontal courses of limestone blocks that are smaller than the main pyramid blocks and dressed on their horizontal faces only. Fine limestone is used for the casing and backing stone. The structure rests on a foundation platform made of two or three courses of limestone blocks, the upper course of which is made of fine white limestone that extends beyond the edge of the pyramid (Maragioglio and Rinaldi 1965: 75-6) for added stability. The walls, ceiling and floor of the entrance corridor and chamber are made of fine limestone. The floor was laid in the rough and dressed at a later stage. The ceiling bocks were dressed prior to positioning, showing a deferential treatment (Maragioglio and Rinaldi 1965: 76-8) probably for ease of work. While the chamber's north wall is completely and very well dressed, the south and east walls are partially dressed, and the west hardly at all. Yet, the manner in which the walls were partially dressed but better dressed than the ceiling could be a sign that the fine limestone blocks were dressed *in situ*. A monolithic block is used for the architrave. A shaft extends from the chamber's floor and is lined with fine limestone, which may indicate its importance (Maragioglio and Rinaldi 1965: 80).

Unlike the wall at Meydum, the perimeter wall of the southern pyramid (299 x 299 m) is square. Its walls (2.5 m thick and est. 2.0 m high) have a batter and bevelled tops. The lowest courses are made of local limestone and the upper ones of fine limestone (Fakhry 1959: 39). As at Meydum, the court surrounding the pyramid was unpaved. A path made of limestone chips, plaster and mud linked the causeway to the cult chapel and a building to the south-east, most probably used for the ritual slaughter of animals (Maragioglio and Rinaldi 1965: 74). The fine limestone causeway (700 m long) built on a *tafl* and limestone flakes foundation is a continuation of the perimeter wall (Alexanian *et al.* 2008: 4). The floor (3 m wide) is made of a layer of mud (Fakhry 1959: 105).

The valley temple (26 x 47 m), which stood on a naturally elevated tongue of *tafl* 150 m west of the lake, is in a wadi that was much deeper than it is today (Alexanian *et al.* 2008: 3-4). Unlike later valley temples, this one has a north-south axis, is built entirely with fine limestone and originally had a mudbrick perimeter wall (60 x 110+ m; Fakhry 1959: 110), which we now know, was an older mudbrick enclosure which Snefru reused (Arnold 2013). The north end of the temple consisted of a porch held up by two rows of five squared pillars made with monolithic blocks of fine limestone (5 m high) fronting a chamber at the back of which were six niches, each containing a life-size statue of Snefru carved out of the same monolithic block (Fakhry 1959: 110-3). The valley temple acted as a liminal structure designed to receive goods brought for the cult of the king. Priests offered to the gods on behalf of the king, as depictions show the king performing rites associated with the *Heb Sed*, such as the *Sed* festival run, visiting shrines, founding temples; funerary estates are also shown bringing offerings to the king and the king is shown providing offerings to the gods (Fakhry 1959: 110-3). The valley temple shows high quality craftsmanship. Unique to this site is a second, lower causeway that links a mudbrick harbour to the valley temple. Although the harbour was not dated and may be late OK and MK, a similar structure may have existed during Snefru's reign. The original lower causeway, which was rebuilt during the 6th dynasty and the MK, departed from the harbour's west wall and consisted of two 140 m long, unroofed mudbrick walls, with a 5º slope. To make up for the unevenness of the wadi floor, walls were built on a foundation layer of *tafl*, limestone flakes and crushed ceramics (30 cm thick), probably building waste used (Alexanian *et al.* 2008: 3-4).

Material Characterisation

The soft limestone, which is yellowish-brown, is a sandy-marly limestone containing shale beds, as at Saqqara, and belongs to the Saqqara Member of the Late Eocene Maadi Formation. The quarries were not easily accessible at Dahshur as they had to be opened on the plateau. Wind-blown sand has damaged chisel marks that would have helped with identification, making them hard to locate. Still, a ramp leading from the east of the pyramid to an area 1-2 km east points to a likely quarry area (Klemm and Klemm

2010: 51-69). Other ramps leading north, east (Vyse and Perring 1840: 63) and southwest (Grinsell 1947) point to other potential quarries.

Some of the fine limestone used for a few of the casing blocks came from an unidentified Western Desert source (Klemm and Klemm 2010: 51). Yet, petrographic analysis indicates that the majority of the fine limestone corresponds to the Maasara type. It came from the south end of the Tura-Maasara stretch closest to the building site, from a gallery quarry most likely at the base of the escarpment (Klemm and Klemm 2010: 66) and was transported 15-17 km upstream to Dahshur.

8.1.3. North Pyramid

Snefru's North pyramid is often referred to as the Red Pyramid because of the slightly reddish colour of the iron oxide-rich limestone used. Though the angle is more obtuse (43º 40') than the one preferred (52º) for all subsequent pyramids, it is the first pyramid built with straight faces (vs stepped faces), something which likely explains Snefru's desire to return to Meydum during the building of the North Pyramid to transform it into a perfect pyramid (see section 8.1.1). The names of the two Dahshur pyramids 'The Southern Shining Pyramid' and the 'Shining Pyramid' suggest that they work in tandem, as a north and south tomb respectively (Lehner 1997: 17). It is not clear if they are the two structures 'Snefru high of the white crown' and 'Snefru high of the red crown' mentioned earlier in this chapter. The dates inscribed on some of the blocks indicate that the North Pyramid was started when the angle of the Bent was modified for a second time (Petrie 1882). The North Pyramid has the same angle (43º 40') as the Bent's final design yet more stable foundations, which suggests that it was started to secure a burial place for the king had the Bent collapsed. It is interesting that the Bent was not abandoned. As is the case with most RMC sites, all that remains is the pyramid with scant traces of other features such as the eastern chapel. Vyse and Perring (1940) and Petrie (1882) excavated the pyramid. Maragioglio and Rinaldi's (1965) survey provides useful information. Later, Stadelmann (1980-1990) and Seidlmayer and Alexanian (1999 to present) carried out more thorough excavations. A pyramid town more than 6 m under the floodplain was located at the edge of the cultivation, as was a causeway now 6 m under the desert surface. The results await publication, but they may help locate a valley temple for the North pyramid (Alexanian *et al.* 2011).

Location and Layout

Snefru's North Pyramid is 2 km north and across from the wadi where the Bent Pyramid's valley temple lies (figs. 8.3.1-8.3; 8.2.5). The proximity means that the pyramids share many locational similarities, most of which are not reviewed here to avoid repetition (see section 8.1.2 and table 9.5). The main difference is that the North Pyramid is set a little further back in the desert (2 km) than the Bent, making it the most set back of all RMCs built until that time Conveniently, the closest large wadi is 2 km due west (Jeffreys 2009). It is noteworthy that rather than moving the building project to a new site, as was done once before with the shift from Meydum to Dahshur, the same location was selected, potentially for logistical reasons.

The pyramid (220 x 220 x 104.4 m) is built on a platform formed by a single course of limestone blocks laid on the levelled desert surface and framed with fine limestone (see tables 9.5, 9.6, 9.7; Maragioglio and Rinaldi 1965: 126). The horizontal courses (0.50-0.70 cm) of the core masonry are very well laid. The casing is made with courses of fine limestone. As with the Bent, the height of the stones used in the lower part of the pyramid is greater than the height of the stones used in the upper part (from 0.90 to 0.60 m; Maragioglio and Rinaldi 1965: 126). The internal apartments are mostly made with limestone masonry. The corridor pavement slabs have the same width as the corridor, and those in the chambers have less than half the width of the chamber, indicating that the slabs were placed before the pyramid was built. The slabs were also laid so as to form a symmetrical pattern departing from the sidewalls showing great degree of care in the execution (Maragioglio and Rinaldi 1965: 130). A number of architraves are made of monolithic limestone bocks. Fine limestone was used to frame the tomb entrance and to case the first antechamber (Maragioglio and Rinaldi 1965: 128).

The eastern chapel (50 x 60 m) consists of a courtyard paved in limestone flanked by two stone chapels to the north and south, potentially representing the house of the north and south, reminiscent of Djoser's RMC and sanctuary built in mudbrick abutting the pyramid. Fragments of 'dark granite' found in a deep excavation could point to the presence of a single stela rather than the customary double, and may have been the remains of a false door, as used from Khufu onwards (Stadelmann 1993: 259-63). Circular holes with a mixture of sand and Nile alluvium in the north chapel's courtyard may have contained plants. No satellite pyramid could be located. Although the exact use of stone could not be determined from the reports for the enclosure, soft limestone is likely to have been used for the masonry and fine limestone for the casing and possibly lower masonry courses (Stadelmann 1993: 259-63).

Material Characterisation

The soft limestone used for the core of the North Pyramid is local and belongs to the Kom el-Shelul formation of the Pliocene that occasionally covers the Eocene limestone from Giza to Beni Suef near Meydum. The limestone, which is brown to reddish-brown, is of a poorer quality than the one used in the Bent Pyramid, ranging from a calcareous sandstone to a sandy limestone that is relatively porous and layered, and at times rich in fossils and oyster shells (Klemm and Klemm 2010: 68). This and the fact that the limestone came from outcrops close to the pyramid made it easier to extract (Klemm and Klemm 2010: 68.). The bulk of the core material came from a quarry 1.2 km southwest of the pyramid that provided a less porous kind of limestone with fewer fossils and was connected to the pyramid with relatively well-preserved ramps. The other quarry is 1.5 km west-southwest of the pyramid (Klemm and Klemm 2008: 57). Fragments of granite have been found on two ramps leading from the northeast corner of the pyramid west toward the valley (Maragioglio and Rinaldi 1965: 132). However, it is unclear whether they lead to local quarries or were used for the transportation of other materials, such as the fine limestone for the casing or even possibly granite, as the fragments suggest.

Although most of the casing is missing, no West Desert fine limestone could be identified. The harder limestone belongs to the Maasara variety, which would have been closer to Dahshur than more northern sources with denser limestone (Klemm and Klemm 2010: 65). Perhaps the need to get harder limestone from Maasara partly determined the choice of Dahshur.

Very little information is available on the workforce. The scant remains of a workmen's settlement was located with a test trench southwest of the pyramid and awaits excavation (Alexanian *et al.* 2011: 2-3).

8.2. Khufu

Snefru's son Khufu, better known as Cheops, built his RMC at Giza. The 23 years assigned to him by the Turin Papyrus are generally accepted as accurate. Khufu's actual name was Khnum-Khufu, meaning the god 'Khnum protects Khufu'. His pyramid's name was Akhet-Khufu, meaning 'Khufu's Horizon' (Quirke 2001: 116), but is commonly known as the Great Pyramid, as it is the biggest and the first to have a 52º angle, which was retained for every subsequent pyramid. Unlike most RMCs, his was finished, and for the first time since Djoser an array of hard stones, notably basalt and granite, were employed, but on a much grander and more visible scale. Khufu's is the most intensively investigated RMC to date. Napoleon's expedition (1798-1801) produced detailed drawings and measurements of the pyramid and parts of the internal apartments. Vyse and Perring (1840) and Lepsius (1843) visited the site. Smyth (1884) and Cole and Borchardt (1926) carried out measurements. Petrie (1883), Junker (1929), Reisner (1942) and Hassan's (1932-53) surveys and excavations of the pyramid and its vicinity, as well as Lehner's (1997-present) ongoing fieldwork, provide the most detailed and systematic information about the site.

Very little is known about Khufu, except that he was the son of Snefru and Queen Hetepheres I. The Turin Canon makes reference to a military campaign in the Sinai and exploitation of the anorthosite gneiss quarries in Nubia, which his father opened (see section 8.1; Maragioglio and Rinaldi 1962: 8). The fact that Khufu was responsible for building the largest pyramid gave him the reputation in later history of being a cruel ruler who called upon thousands of slaves to construct a monument to his own glory. As discussed in Chapter 2 (see section 2.3.), evidence from the workmen's village at Giza paints a different picture of a well-organised project employing paid part- and full-time workers (Lehner 2004).

Location and Layout

Khufu's RMC at Giza is 20 km north of his father's at Dahshur, 14 km north of the capital, which is double the distance of his father's at Dahshur (c.7 km) and 5 km north of Khaba's unfinished RMC at Zawyet el-Aryan (see tables 9.2, 9.4. figs. 2.17; 8.4.1-8.4.7). The closest visible RMC was Djoser's, 14 km south at Saqqara by the capital. Although considered here the second northernmost RMC after the unassigned mudbrick structure built in the floodplain at Abu Rawash, Khufu's was the northernmost visible

RMC with the highest elevation (61 m) at the time of construction. ED burials in the wadi south of the plateau and a 3rd dynasty mastaba tomb-known as Convington's tomb -1 km south of Khufu's pyramid indicate that Giza was not a virgin site (Lehner 1985b; Martin 1997; Der Manuelian 2009). In stark contrast to Snefru's RMCs at Dahshur, Khufu's is much closer to the edge of the escarpment (410 m), which, after having been reworked as a quarry, formed an impressive 30 m cliff. The main wadi entrance 530 m to the south defines the southern limit of the plateau while a much larger wadi 700 m to the north defines its northern limit. The river was c.800m due east and Giza was connected to it by means of a canal (Bahr el-Libeni; Lutley and Bunbury 2008). A harbour (Hawass 1997) was at the foot of the escarpment. The Giza plateau is a limestone outcrop which belongs to the Middle Eocene Mokkatam Formation and is of excellent quality; it has been severely modified by quarrying and levelling activities (Klemm and Klemm 2010: 69-70). The surface is relatively regular with a slight 5º-10º dip to the southeast (Lehner 1985a: 112-7). A number of fault lines run through the site; the OK surveyors avoided the major ones (Klemm and Klemm 2010: 71-2).

Khufu's RMC has a typical OK layout with three small pyramids for Khufu's queens, and seven boat burials. The RMC appears to have been built in a single effort. A cemetery for the royal family and high-dignitaries lies between the pyramid and the escarpment to the east; one for lower-ranking officials lies to the west (Porter and Moss 1974: 47-211; Roth 1993).

The pyramid (230 x 230 m, 146 m high) was built around a rock-knoll, something that characterises all northernmost RMCs at Giza and Abu Rawash and increases the stability of the structure while decreasing the amount of blocks required for the core (see tables 9.5, 9.6, 9.7; Klemm and Klemm 2010: 90). The preparation work for the pyramid is impressive; builders no doubt wanted to avoid the problem Snefru had faced at Dahshur with his South Pyramid. The knoll, the actual size of which is unknown, was cut into steps, with its crevices filled with blocks and mortar; the surface around it was levelled and the area closest to the knoll was cut to receive inward inclined foundation blocks. The foundation pavement was made of blocks of fine limestone, regularly cut, well-fitted with parallel and very fine joins for the outer courses; soft limestone was used further in (Maragioglio and Rinaldi 1962: 12). The outer masonry courses placed behind the casing are made with very large, more-or-less squared, well-laid blocks of limestone of varying dimensions, weighing 2.5 tons on average. As at Dahshur, the lower portion comprises larger blocks that form higher courses than the upper that comprises smaller blocks. The core is poorly executed, consisting of rubble infill and blocks of varying size cemented with a very hard, pink mortar. This construction method was probably to expedite this part of the construction (Lehner 2002: 4-5). The casing, of which only a few casing blocks remain, shows a great degree of skill and craftsmanship (Maragioglio and Rinaldi 1962: 16). It was made with fine limestone blocks that vary in dimension and weigh 15 tons on average. The blocks were well joined, with workers often leaving less than 1 mm between the blocks and using a gypsum mortar as a lubricant to facilitate the joining, to infill levering notches and cement the blocks (Maragioglio and Rinaldi 1962: 18). Altogether, the construction shows a great degree of planning and expertise in the different modes of construction designed to increase (a) the structure's stability, and (b) the construction efficiency.

The internal apartments of Khufu's pyramid are possibly the most complex of the 4th dynasty RMCs. The entrance corridor is part masonry, part rock-cut, as is Snefru's, and lined with fine limestone until it reaches the rock-knoll where it leads to a rough-cut chamber with a pit cut in the floor. This chamber leads to another, unfinished one with a dressed ceiling but particularly uneven floor and walls; a small tunnel leading nowhere continues south (Maragioglio and Rinaldi 1962: 22). Another masonry-built corridor, also lined with fine limestone and closed with three pink granite plugs, leads up from the ceiling into the Great Gallery, known for its impressive corbelled ceiling made with limestone beams weighing up to 25 tons, and leading to the Queen's Chamber, the walls and ceiling of which are lined with fine and well-dressed limestone (Maragioglio and Rinaldi 1962: 18-22). A corridor lined with fine limestone leads to a chamber almost entirely faced with pink granite and that contained three portcullises (Maragioglio and Rinaldi 1962: 24). It is unclear what material the portcullises were made of, but given the logic of the material orchestration so far, it was likely to have been pink granite. From this chamber, the corridor that is faced with pink granite leads up to a burial chamber, entirely faced with granite and containing a pink granite sarcophagus. The ceiling is made of nine beams of pink granite. Five relieving chambers took most of the weight of the masonry off the burial chamber. The uppermost chamber's beams are limestone; the four lower ones are pink granite (Maragioglio and Rinaldi 1962: 24).

Of the eastern chapel – hereafter referred to as a mortuary temple given its dimensions – only the foundations remain (52 x 43 m). With limestone walls 6m thick, it consisted of a large, basalt-paved courtyard, with 40 pink granite columns (c.1 m wide; Lauer 1957). Evidence suggests that two side chambers flanked the inner sanctum on the north and south. Traces suggest fine limestone lined the walls and upper portions of columns (Hassan 1960: 40-2). The satellite pyramid (21.75 x 21.75 m), of which only the foundations remain, was a small version of the main pyramid. The core was built with large blocks of local limestone and construction debris, the internal passages were rock-cut and the casing and outer foundations were made of fine limestone (Hawass 1996: 381-5). The three queen's pyramids are larger (49 x 49 m) and have stepped rather than smooth sides. The masonry consists of local limestone blocks. Fine limestone cased the exterior and lined the burial chambers (Maragioglio and Rinaldi 1962: 76-96). Anorthosite gneiss may have been used for the arrises of the satellite pyramid or one of the queen's pyramids (Petrie 1883: 136). There were two perimeter walls. The outer one was plastered (c.3 m wide) and made of rubble and slightly inclined (Petrie 1883: 136); the inner one (252 x 252 m) was made with blocks of limestone and inclined, with bevelled tops, and had thicker walls (3.15-3.6 m) than previous RMCs. The pavement between this wall and the pyramid was paved with irregular slabs of fine limestone laid on a levelled surface (Maragioglio and Rinaldi 1962: 66).

The causeway (660 m long, 9 m wide), of which only the foundations remain, was built with limestone blocks (Maragioglio and Rinaldi 1962: 68). Traces of pink granite were found, suggesting some granite may have been used in causeway construction. Scattered blocks indicate that the causeway was decorated with carved reliefs depicting royal scenes of the king performing He-Sed rituals and visiting shrines (Hassan 1939: 20-3), a similar iconography to the depictions in Snefru's valley temple (Fakhry 1961: 98-110). For Herodotus (*Histories* 2.124-6), the causeway was as much a feat of construction as the pyramid itself. Little is known of the valley temple and harbour of Khufu's RMC, as the remains are now buried under the village of Nazlet el-Samman (Goyon 1969, 1971; Messiha 1983). The valley temple is estimated to have covered an area of 50 x 50 m (Messiha 1983: 16), with its masonry at least part-formed of large limestone blocks (2.5 x 1.0-1.5 m). Slabs of basalt, of similar dimensions, cased the lower course of an east-west running corridor; fragments suggest the use of mudbrick and some granite was also used, probably for finer features (Messiha 1983: 14-5). The harbour, by the valley temple, was due east of an older harbour that was abandoned after a change in the course of the Nile and was eventually infilled by sand. The remains of a battered limestone masonry wall running north, packed with limestone chips and cased with basalt and limestone, were found and could have been a city wall. The limestone blocks, irregularly cut, vary in size, with some up to 2.0 m long and 1.0 m thick. The basalt blocks are trapezoidal and are as much as 1 m long and 0.60 m thick (Hawass 1997: 248-9). Further away, limestone blocks covered with basalt slabs were found.

Material Characterisation

Limestone is the most conspicuous construction material used across the Khufu's RMC. It was used for the masonry throughout the entire complex. Limestone was also reworked for levelling, stepped-core, foundations and internal apartments. The limestone, which is grey-yellow and nummulitic (containing fossils) and belongs to the Middle Eocene Mokkatam formation, is of a good quality (Klemm and Klemm 2008: 42-3). The main quarry, which is 500 m south of Khufu's pyramid, has two drag ramps leading to the southwest and southeast corners of the pyramid (Klemm and Klemm 2008: 42-3). The escarpment east of Khufu's pyramid was also used as a quarry, creating a more impressive straight cliff. The causeway may have originally served as a drag ramp from the valley and later modified (Klemm and Klemm 2010: 76-7). Stone was also obtained from levelling the plateau and from Hitan el-Gurob further south along the escarpment. Although this cannot be confirmed, the Western and Eastern mastaba fields may also have been quarries. Part of the northern escarpment provided materials for other structures on the site, such as the private mastabas (Reisner 1942; Klemm and Klemm 2010: 77). Lehner (1985b; 1997: 108) estimated that Khufu's pyramid alone used 2,590,000 m^3 of stone and that 2,760,000 m^3 were removed from the quarry, representing 93% of all the stone required. Khufu consumed less limestone than his father Snefru, but used local quarries that were closer to building sites and provided better quality limestone. Though their size varies, the blocks quarried are much larger than in previous RMCs. However, these large blocks were not used consistently throughout, as the rubble and knoll core indicate. Although much levelling was required, levelling was much easier to execute than shift blocks from the quarry.

Fine limestone was used for the foundation's outer courses, as with Snefru's North Pyramid at Dahshur, the pyramid's surrounding pavement, and the casing of the main, satellite and queens' pyramids. Fine limestone was also the material comprising the wall-lining in the mortuary temple, the pyramid's masonry corridors, and the walls and ceiling of the Queen's Chamber. Petrographic analysis indicates that the fine limestone likely came from a gallery quarry at Tura (Klemm and Klemm 2010: 88), conveniently located north of the quarry stretch and almost directly opposite Giza on the east bank. This entailed transporting the limestone 16-18 km across the valley to the harbour rather than upstream, as was the case with Snefru. While Stocks' (1986a, b; 2003: 169-78) experiments show that harder limestones could only be dressed with stone tools, Lehner's (1997: 211) team at Giza identified fine limestone blocks that had been dressed with c.8mm wide soft copper chisels.

For the first time since Djoser, granite is used again in an RMC, but at a greater scale, with an increase in overall volume, unit size and craftsmanship. Granite was used to line Khufu's burial chamber, as relieving beams in the chamber, and as the material for the sarcophagus and column bases in the mortuary temple and valley temple; and it may also have been used in the causeway, as fragments indicate. As mentioned in section 7.1, the acquisition of granite, especially large units, was most likely seasonal and meant transporting the stone over c.700 km downstream from the Aswan quarries to Giza (Kelany *et al.* 2009). For the first time there is clear evidence regarding expertise of sawing and drilling in granite consumption in Khufu's RMC. Experts would have processed the stone at the more intricate stages of manufacture, such as the sawing, drilling and carving required for Khufu's sarcophagus. The skills were directly borrowed from the specialist workforce traditionally attached to stone vessel production. Here the skills were transferred to the larger pieces that monumental architecture required (Klemm and Klemm 2001). Through his own experimentation, Stocks (2003: 169-76) estimated it would have taken a team of three men four to ten months or c. 28,000 worker hours to saw and drill Khufu's sarcophagus, time to which may be added a few more months for dressing and polishing. Stocks (2003: 169-76) also estimated that it would have meant consuming c.168 kg of copper for the saws and drill-tubes used, and c.14.5 and c.22.5 tons of sand respectively.

Although Djoser may have used basalt in his RMC at Saqqara, Khufu is the first and only king in the period under study to deploy basalt on a monumental scale. Basalt was used to pave the 1,500 m^2 of his mortuary temple's courtyard, as well as in unknown quantities to line floors and lower wall courses in his valley temple and harbour. Basalt was obtained from a quarry 60 km southwest of Giza, at Widan el-Farras in the north Fayum; although outcrops existed closer to Giza, these did not yield the large units necessary for use in architecture (Harrell and Brown 1995). The stone was obtained from outcrops on the tops of hills. The basalt's natural weathering and break patterns made it relatively easy to quarry into roughly shaped blocks, some of which are up to 1 m^3. The valley temple and harbour blocks' trapezoidal shape indicates that the quarrymen exploited the natural cleavage lines when extracting the stone in the quarries (Hawass 1997: 249). All the blocks required was levering out of place after which the workmen let them slip to the bottom of the escarpment, where they would be slid onto a 2 m wide ramp made of basalt, silicified wood and sandstone and transported 11 km south to a harbour on the ancient northern shore line of Lake Qarun, at Qasr el-Saga. There they were eventually loaded onto a boat (Bloxam *et al.* 2009). The stone tools found at the quarry come from other distant and remote quarry sites, such as the anorthosite gneiss or granite ones over 800 km to the south, hinting at a mobile, specialist workforce (Bloxam *et al.* 2009). The basalt was then transported 300 km upstream via the Bahr Yussef and then downstream for again for 300 km to Giza. The fact that the peak of consumption of large units of basalt in OK RMCs coincides with high-flood years implies that transportation of the large units in such volumes depended on high floods and could only take place during the three months of the summer inundation, as the increased volume of water was essential to pass the shallow Lahun-Hawara gap. Hence acquisition of large units, as in the case of granite, was seasonal (Brown and Harrell 1995: 83; Harrell 2002: 236). While minimal dressing was done at the quarry site, removing just enough to reduce the blocks' weight for transportation, most of the finer dressing was done at the construction site. The basalt pavement blocks used in Khufu's mortuary temple are the first evidence that blocks of stone were sawn. In some cases, workers sawed blocks to start separating them and then broke them off with a hammer; in others they started with hammer picking, and finished with a saw (Petrie 1883: 174-5; Maragioglio and Rinaldi 1962: 69-72; Moore Jr 1991: 141-4).

Evidence suggests that gneiss may have been employed to case the arrises, or corners, of at least one of the subsidiary pyramids at Giza. If Petrie's (1883: 136) identification of the material and interpretation are correct, then it is the second and only other known architectural use of gneiss in an RMC, after the paving blocks used in Djoser's burial chamber (Quibell and Firth 1935: 29, 46, 56). This, and the fact that gneiss is generally only used for vessels and statuary, makes its presence in Khufu's RMC particularly high-profile. It is unfortunate that Petrie does not give any measurements of the arris. Yet it is possible that a relatively small group of workers would have been required to handle this task, making the logistics of gneiss consumption comparable to that for the gneiss stone vessels and similar to Djoser's (see section 6.1). Gneiss came from the remote Gebel el-Asr quarries more than 800 km south in Nubia. (Please refer to section 6.1 for the logistics of acquisition.)

With his conspicuous consumption of basalt and granite, and possibly gneiss, Khufu expanded consumption of bulk material for RMCs from a regional scope of acquisition to a national scale, building on his father's acquisition patterns to include harder stones from more remote sources.

8.3. Djedefre

Khufu's eldest son and successor Djedefre built his RMC at Abu Rawash. Djedefre, whose name means 'Enduring like Re', was the first ruler to receive the title Son of Ra. His Horus Name, Kheper, which means 'Horus Appears' also has strong solar connotations, altogether pointing to the sun-cult's increasing importance (Verner 2001: 217), which some propose was the reason, as mentioned in Chapter 2, for choosing Abu Rawash for his RMC, which is across the valley from Heliopolis. Little remains of his complex which was completed in mudbrick but which later quarrying activities severely damaged (figs. 8.5.1-8.5.6; Valloggia 2000: 154). Vyse and Perring (1840), Lepsius (1843) and Petrie (1883) briefly surveyed the site and Chassinat carried out the first systematic investigations of the complex (1901), followed by Lacau in 1912-1913. Maragioglio and Rinaldi (1966) also surveyed the site. Valloggia and his team carried out extensive excavations at the site between 1995-2007, providing the most complete and up to date information about the complex.

Until recently, not much was known of Djedefre. The complex's poor state of preservation, and the later NK king list (Turin Canon) assigning Djedefre 8 years of rule, led historians to see Djedefre as a renegade king, whose RMC and memory his successor Khafre deliberately destroyed. Fortunately, recent archaeological investigations have shed further light on Djedefre's reign (Valloggia 1997, 2001). A block found in the descending corridor of his pyramid bearing the date 'Year 1 of the count, 3rd month of Peret', shows that Djedefre began building his RMC the moment he came to power. A block from one of his father's boat pits at Giza placed during 'the year after the 11th count, 1st month of Peret, 24th day' indicates that Djedefre reigned for 23 years at least (Valloggia 1997: 419), but also that he likely undertook the building of his RMC while finishing that of his father. This could explain many of the decisions surrounding the size, and planning of the complex as well as selection of materials.

Location and Layout

Djedefre's RMC is 8 km north of his father's, 22 km from the capital, which is the same distance that separates it from Heliopolis and c.2 km from the unassigned mudbrick RMC at Abu Rawash, at the foot of the hill. Yet the closest most visible RMC would have been his father's, 8 km south at Giza. Djedefre's and the unassigned RMC at the foot of the hill are the northernmost RMCs, yet Djedefre's is the most visible given that it is the highest OK RMC (150 m). The pyramid is currently 100 m from the escarpment's edge, which, after having been reworked as a quarry, forms an even more impressive 70 m cliff, more than double the height of his father's (see tables 9.2, 9.4.). The bedrock and surrounding hills consist of layers of good quality Turonian limestone. The limestone dates to the Upper Cretaceous and belongs to the Wata formation (Klemm and Klemm 2010). The main wadi is the large, slow-rising Wadi Qaren northeast of the pyramid, where the causeway was built, which connects the upper portion of the complex to the cultivation. The river is estimated to be 2 km east (Bunbury and Lutley 2008); a canal would have connected it to the RMC's valley temple. A 3rd dynasty minor step pyramid built in mudbrick known as el-Deir stood to the north of the wadi mouth (Macramallah 1932; see section 6.4 and Chapter 9). About 1 km south of the wadi entrance are two cemeteries; the ED cemetery M dominated by mudbrick tombs and the other cemetery F dominated by stone tombs and dated to the 4th dynasty. These two cemeteries were respectively built at what was then the north and south ends of a slight elevation across from the earlier mudbrick structure discussed in section 6.4, here considered a potential RMC (Swelim 1987a). From the Delta, Djedefre's RMC would have towered over a relatively built-up area.

Djedefre's RMC has a typical OK layout. In contrast to his father's RMC, it only had one boat pit and the complex shows distinct building phases outlined below. It is unclear if cemetery F can be considered as the associated cemetery.

The pyramid (106 x 106 m, 67 m high), which now stands at a reduced height of 15 courses, was much smaller than previous 4th dynasty RMCs (see tables 9.5, 9.6, 9.7). As in the case of Djedefre's father's pyramid at Giza, it was also built around a central rock-knoll. The ruined state of the pyramid revealed that the knoll at its core reached a height of 12.3m, representing almost half, or 44%, of the superstructure (Valloggia 1999: 56). It was also cut into terraces to receive blocks, some of which measured up to 2 m^3 and weighed 5.4 tons (Valloggia 1995: 70). The surrounding bedrock was prepared to receive the lowest courses and casing (Valloggia 1995: 68-9). The lower 20 courses were cased with pink granite to a height that corresponds to the top of the rock-knoll (Valloggia 1999: 50). This is the first recorded occurrence of granite being used to case a pyramid.

The layout of the internal apartments is much simpler than Khufu's, consisting of a large, rock-cut, T-shaped, open-trench. The wide descent (5.5 x 44.25 m) was transformed into a corridor by lining its wall and floors, and adding a ceiling with fine limestone (Valloggia 1997: 418). Three courses of well-cut and finely laid limestone blocks lined the floor. Although this cannot be proven, fragments of granite are conspicuous enough in the corridor to suggest that it may have been used in some unknown measure (Valloggia 1997: 419). The corridor leads to a well-dressed rock-cut burial pit (23 x 10 m, 21 m deep) lined with fine limestone (Valloggia 1998: 84), the floor of which was lined with five courses (450 m^3) of very well-laid fine limestone blocks (Valloggia 1997: 132). The burial chamber walls were first lined with fine limestone blocks and finally cased with pink granite (Valloggia 1996: 84). The burial pit was covered with three courses of granite beams laid in chevron, with one beam measuring 1.2 x 1.05 x 2.2 m (Valloggia 1997: 130) and had the hieroglyph for pure, *ouab*, painted in red on it. Alternating layers of limestone masonry blocks, and earth and rubble infill covered both corridor and pit (Valloggia 1996: 59).

The eastern chapel (66 x 30.5 m) follows the north-south axis imposed by the local topography (Valloggia 2000: 151). While the outer battered walls (4.1 x 3.6 m) were made of dry limestone blocks and plastered (Valloggia 2000: 154), most of the internal walls were made with mudbrick (Valloggia 1997: 125). The temple consists of five interdependent structures. There were magazines to the north; an open-court with a mud-plaster floor and housing for priests was built against the eastern perimeter wall, after the wall been extended. A limestone structure was built around a boat pit to the south, in which 120 quartzite statues of the king were placed, but subsequently destroyed by the Romans (Valloggia 1997: 125). To the west is a limestone-paved courtyard with a pillared hall where chapels stood that had once contained statues of the royal family; to the south is a chapel dedicated to the king's cult. Remains of a column with Djedefre's name are the earliest evidence of monolithic columns (Verner 2001: 220). A satellite pyramid (10.5 x 10.5 m) at the main pyramid's southeast corner, later used for one of Djedefre's queens' burial, had an unsquared limestone block core with large blocks used for the outer masonry. Evidence suggests that the satellite pyramid was uncased. The substructure was rock-cut (Valloggia 2001: 443-4). As with his father's RMC at Giza, there were also two perimeter walls. The outer one, with the pyramid in its centre had thick walls (5.25 m); the inner one was closer to the pyramid and surrounded the cultic buildings. Both walls were built in a similar manner to the lower section of the causeway, but with plastered exteriors (Valloggia 2000: 151, 449). An artificial terrace formed by blocks of limestone strengthened the area between the eastern wall and the cliff (Valloggia 2007: 257).

Building on the style of his father's exceptional causeway at Giza, Djedefre had a truly monumental causeway built, the scale of which remains unsurpassed. Only the foundations and a few wall sections remain. Measuring 1.5 km long (9 m wide) it ran up the Wadi Qaren in a northeast direction with a uniform 5º rise and is the longest causeway ever built for OK RMCs. The lower section's walls are made with unsquared blocks of limestone filled with loose rubble, similar to the Gisr el-Mudir, and the floor is a prepared mud-matrix with construction debris laid on smoothed bedrock (Maragioglio and Rinaldi 1966: 24). The upper section was built by cutting and shaping limestone bedrock into two limestone projections 8 m apart (Maragioglio and Rinaldi 1966: 24), integrating local topography into the architecture, as with the rock-knolls. Nothing remains of the valley temple except a few rare blocks of limestone (Chassinat 1901). Trial trenches carried out in 1901 did not reveal any structures (Chassinat 1901).

Material Characterisation

Limestone is the most conspicuous material used across the RMC. Limestone masonry is used for the pyramid and satellite pyramid, boat pit structure, perimeter walls and the exterior only of portions of the causeway, and possibly the valley temple, although this cannot be confirmed. As at Giza, the builders used a natural knoll that reduced the amount of stone blocks that had to be quarried, and also reduced the effort surrounding their transport; at the same time stability was added to the structure (Valloggia 1999: 54). An important portion of the causeway was also cut away. The local limestone provided immediately available high-end material. The limestone, which is grey-white in colour, relatively soft, but extremely fine-grained with no fossils comes from thick layers (up to 130 m) of the Turonian limestone, was interspersed by veins of calcite/travertine. A yellow-grey, dense limestone with occasional yellow patches and fossils, also interspersed with fine calcite veins (Klemm and Klemm 2010: 104), was also used. Petrographic analysis shows that the limestone blocks used for the masonry came from a restricted area, suggesting a single quarry source (Klemm and Klemm 2010: 106). While some of the blocks for the pyramid's lower courses may have come from the excavation – that is, the excavation of the shaft and burial chamber, terracing of the knoll and levelling of the surrounding bedrock – the blocks used for the higher course most certainly came from a quarry located 1.8 km northeast of the RMC in the Gebel Madawarah Hills (Klemm and Klemm 2010: 106). This quarry provided a minimum of 200,000 m^3 of stone; some of it may have been used for the 4th dynasty mastabas in cemetery F. Hence the limestone had to be transported over a greater distance than at Giza and over a greater difference in terrain (up to 150 m).

Fine limestone was used for the floor and walls of the descending corridor, the floor of the burial pit and walls of the burial chamber. If the pyramid was not entirely cased with granite, granite may have been used for the upper casing. As fine limestone is one of the most reused materials, it would have been removed early on. Scientific testing was not carried out on the fine limestone at the Abu Rawash complex and it remains unprovenanced. However, if each king did open a new gallery quarry in the Tura-Maasara stretch for their RMC (Klemm and Klemm 2010: 63) and favoured a location closest to the building site, a quarry at the northern end may be posited, entailing transportation 23 km downstream and then up a 5º slope over about 1.5 km. This may explain what appears to be a reduced consumption compared to Giza.

Granite was also used in what seems to be a relatively conspicuous manner at Djedefre's RMC. As with Djedefre's father at Giza, granite was used to case the entirety of the burial chamber and for the three courses of granite beams laid in chevron, with beams measuring up to 5.2 m in length and 1.1 m in height; this represents quite a feat of engineering (El-Naggar 2005: 432). Evidence suggests that the pyramid was cased with granite at least up to 12.5 m, although the major reuse of building materials at Abu Rawash makes it impossible to ascertain whether Djedefre's tomb was ever entirely cased in granite. The possibility should not be excluded. The added stress granite casing imposed may in part explain the reduced height of the pyramid and the fact that the rock-knoll represents almost half of the superstructure; perhaps the knoll even determined the casing's height. The granite from Aswan was transported an additional 8 km to that required for Giza, which is not much more, but unlike at Giza, the material had to be heaved a distance of 1.5 km and up a 5º slope. Granite workshops are well attested on-site and show different processing stages. It seems that the granite was delivered as roughly dressed blanks, the weathered faces removed and the blocks then shaped into their final form, all on-site (Klemm and Klemm 2010: 105). Of significance is the skill required for creating inclined planes for casing, which was hard to achieve and hence is considered a specialist skill (Arnold 1991: 49-50), one that would have been made much greater with granite's hardness. The casing blocks had already been smoothed before placement in the structure, which differs from what is later seen at Menkaure's pyramid (Arnold 1991: 49-50). Such a degree of finish before the placement of the granite element in the structure points to a very careful and expert workforce used for the manipulating of the blocks, in addition to the specialist workforce present on-site for most stages of the granite manufacture.

It is interesting that no basalt is attested at the site, given Djedefre's father Khufu's extensive consumption of basalt and the presence of a basalt outcrop near Abu Rawash (Bloxam 2004: 140). The possibility that basalt had been used and later robbed can be rejected, as reuse leaves obvious traces of reworking on-site. Although the reasons for the lack of basalt remain unclear, it confirms that the local outcrop was not used in antiquity and that Fayum basalt was preferred, as it could provide the larger units needed in architecture (Aston 1994: 19). Djedefre chose to discontinue the use of this material, which would not be used again until the 5th dynasty RMCs at Abusir. His decision was based either on religious considerations or on practical/logistical reasons, such as low floods (Mallory-Greenough *et al.* 2000). Perhaps the small workforce attached to the crafting of basalt (Bloxam and Storemyr 2002) was still busy at Giza completing his father's RMC, or was redirected to the crafting of other hard stones at Djedefre's or his father's site, possibly highlighting the small, specialist nature of part of the workforce associated with RMC building.

Gneiss was not used architecturally but it was used at least for one small statuette of Djedefre that was later reused as a pounder (Vallogia 2000: 154). It is the first time that quartzite, which was used to make the statues of the king, is attested at an RMC site. The stone most probably came from the quarries across the valley from Abu Rawash, just south of Heliopolis 23 km to the northeast (Klemm and Klemm 2010: 103).

Mudbrick could not be tested scientifically for provenance. The material, however, remains conspicuous onsite and was used for most of the internal walls of the eastern chapel. The mudbricks were most likely produced in the valley, 2 km from the site, and then brought up on site. However, the mud floors, mortars and plasters used for the eastern chapel but also enclosure walls required transporting significant amounts of water at least 2 km and up a 5º slope to the site, probably via the causeway before its completion, as at Giza.

8.4. Khafre

Djedefre's brother and successor Khafre (Dodson and Hilton 2004: 52-3) built his RMC next to his father Khufu's at Giza, where, as a prince, a mastaba had been built for him in the westernmost row of his father Khufu's Eastern Cemetery (Hassan 1832). With his choice of location, Khafre broke the tradition of setting up a new royal necropolis observed since Khaba (see section 7.3). Contemporary written evidence from a tomb at Giza and masons' marks from Khafre's pyramid, which give 'year 13 of the biannual cattle count', indicate that Khafre reigned between 22-26 years (Spalinger 1994: 287). Khafre means, 'He Appears like Re' and the name of his pyramid was Weren-Khafre, meaning 'Khafre's Pyramid is Great' (Stadelmann 2001). Khafre's reign is known for an increase in the ruling family's involvement with the sun cult at Heliopolis, which is often interpreted as a sign of the growing power of the clergy during this period (Goedicke 2000). During Khafre's reign, only members of the royal family held high positions in state administration, both in the capital and throughout Egypt. His pyramid cemetery is not as extensive as his father's, nor does its layout follow a unified plan (Roth 1993). In addition to his RMC, the Sphinx at Giza is generally attributed to Khafre (Goedicke 2000: 45-6). His complex is one of the best preserved, especially the granite-dominated valley temple. In 1818 Belzoni first entered the pyramid followed by Vyse and Perring (1840) who were the first to survey the site, which Lepsius also later visited (1943). Petrie (1883) investigated both the pyramid and valley temple. Hölscher (1912) cleared the entire site and carried out the first systematic survey. Hassan's work on the complex (1929-1935) focused on the valley temple and causeway. Maragioglio and Rinaldi's (1966) survey provide useful insights on the construction of the complex. Lehner and Hawass carried out modern investigations of Khafre's RMC.

Location and Layout

Khafre's RMC is at Giza, 8 km south of his immediate predecessor Djedefre's at Abu Rawash and 14 km north of the capital (see tables 9.2, 9.4.; figs. 8.6.1-8.6.3). The closest most visible RMC was that of his father and founder of the 4th dynasty royal necropolis at Giza, 450 m to the northeast. Khafre's is set further back into the desert than his father's (680 m vs 410 m) and is on higher ground (70 m vs 60 m), probably in an effort to avoid Khufu's quarry to the southeast and to effect a general symmetry with the local topography (Lehner 1985a: 151). The local wadi entrance is immediately south of Khafre's valley temple and the harbour lies 600 m northeast and connected to the river 1 km east of the pyramid (Lutley and Bunbury 2008: 5; Bunbury *et al.* 2009: pl. 8-9). The upper section of the RMC is built on a thick layer of limestone, the source of which belongs to the Mokkatam Formation (Lehner 1985a). As mentioned earlier in section 8.2, the bedrock is of a very good quality, but the desert surface dips from northeast to southwest. Thus, as with his father's RMC, a lot of prime building material was immediately available, but Khafre's RMC required significantly greater amounts of levelling; about 10 m of bedrock were cut away for the northwest corner of the pyramid court. A small, central knoll was left, and terraces were cut to form the core of the pyramid (Lehner 1985a: 151); this same technique was used with Khufu and Djedefre's pyramids, and the unassigned mudbrick structure at Abu Rawash.

The rock-knoll represents about one third of the pyramid (215 x 215, 143.5 m high; Klemm and Klemm 2008: 43). As with his father Khufu's pyramid, the area around the knoll was prepared. On the pyramid's north- and southeast sides, the surface was shaped to form the lowest two courses. For the rest, the bedrock was cut with an inward slope and received blocks that were shaped to fit the incline (Lehner 2002: 5). About two thirds of the pyramid is masonry which, like Khufu's, consists mostly of a loose, irregular in-fill with blocks and courses ranging in height (0.23-1.0 m; Lehner 2002: 5). Large gaps were left between the joints, but, unlike Khufu's pyramid, mortar was not used (Lehner 2002: 5). Reminiscent of Djedefre's pyramid casing, the two lowest courses were made of pink granite. In some cases the granite blocks were so large that no backing stone was required. In others, the blocks had naturally rounded backs as if they had been collected as boulders, so that the limestone backing blocks were cut to accommodate the shape of the casing stone and rubble sometimes added as infill Lehner 2002: 5). In other instances, the back of the granite blocks was perfectly smoothed and fitted to the limestone backing stone with mortar. The lowest course was sunk into the ground, adding stability (Lehner 2002: 5). The rest of the pyramid was cased with fine limestone. The backing stones were most often fine limestone (Maragioglio and Rinaldi 1966: 48).

Unusually, the pyramid had two entrances, one 12 m above the ground, the other at courtyard level, both 12.5 m east of the north face's centre. The lower entrance corridor walls were plastered, while those of the upper corridor and its ceiling were lined with pink granite. The blocks are regularly cut (1.2-1.4 x 3 m) and well-dressed (see tables 9.5, 9.6, 9.7; Maragioglio and Rinaldi 1966: 52). The horizontal corridor and burial chamber are rock-cut and open-trench. The walls of the corridor were lined with fine limestone. The roof of the burial chamber is a pointed, gabled ceiling made with at least 34, and maybe up to 54 beams of limestone (2 m thick and 4.5 m long; El-Naggar 2005: 432-3) with many masons' marks (Petrie 1883: 105). The floor of the burial chamber was partly paved with slabs of fine limestone; the western portion, around the sarcophagus, was paved with pink granite. The sarcophagus is made of black granodiorite and was sunk into the bedrock up to the level of its lid. It shows saw marks and the interior was drilled out. Both the interior and exterior were very well polished. Two granite portcullises were found in the internal apartments, one for the burial chamber and one to seal the second, ground-level entrance (Petrie 1883: 105-9). The exterior of the pyramid was cased in fine limestone except for the two lowest courses that were pink granite.

The mortuary temple was built at a distance from the pyramid, with a courtyard separating the two monuments. The temple consisted of five basic elements, an entrance hall, an open-court, an offering hall, five statue chapels and storehouses built with limestone masonry mostly on bedrock; sections to the north and south were built on a 2.5 m thick foundation platform formed of large blocks of limestone (Maragioglio and Rinaldi 1966: 64). Some of the temple's larger masonry blocks measure 72 m^3 and weighed around 180 tons, with the largest ones c.170 m^3 and 450 tons (Maragioglio and Rinaldi 1966: 66). The temple's outer casing pattern is reminiscent of that of the pyramid, with the lower courses cased in pink granite and the upper sections with fine limestone. Evidence suggests that most of the internal walls and ceilings were cased with pink granite. For the first time since Djoser, travertine is used in an RMC, here to pave the floors; one storeroom had its floors and walls entirely cased with travertine (Hölscher 1912: 24-8). All of the temple's surfaces were polished (Maragioglio and Rinaldi 1966: 64). A total of 26 square pillars (1 m wide) made of monolithic blocks of granite were inserted to a depth of 1 m into the bedrock floor and smoothed *in situ*. One L-shaped granite casing block and several inscribed pieces of granite, such as a door lintel with a torus, were also found. Wood of an unknown variety was occasionally used for roof beams and doors (Maragioglio and Rinaldi 1966: 68).

The satellite pyramid (20 x 20 m), of which only a few blocks remain, was built on a limestone foundation platform laid on levelled bedrock. The masonry comprised limestone blocks, some of which were very large; the casing was fine limestone, the internal apartments were rock-cut and a small perimeter wall (with walls 1.05-1.1 m wide) was made of small blocks of roughly squared limestone and probably finished with gypsum plaster (Maragioglio and Rinaldi 1966: 88). Khafre had five boat pits cut into the bedrock, three south of the mortuary temple and two to the north (Hassan 1946: 56-65). The courtyard around the pyramid was levelled and paved with well-laid slabs of limestone (30-40 cm thick), irregular in size and shape. The bedrock underneath was prepared to receive each individual slab, and cracks were filled with building debris or sand, representing considerable work (Maragioglio and Rinaldi 1966: 72). As with Khufu's RMC, an inner perimeter wall was built 10 m from the pyramid, with bevelled topped and slightly wider walls (3.25-3.60m) than the causeway's. The foundation blocks are fine limestone laid on and cemented to the levelled bedrock with a thick coat of very hard, pink mortar; the southeast corner was built on a masonry platform. The core was probably rubble and the casing fine white limestone (Maragioglio and Rinaldi 1966: 74).

Khafre's causeway (495 m long), of which only the foundations remain, had walls (3 m thick) and its floor lined with fine limestone (Maragioglio and Rinaldi 1966: 74). It follows a rocky ridge that was cut and levelled. Some sections that cut through Khufu's quarry were built on embankments formed of large blocks of limestone (Lehner 1985b: 151). The causeway reached the valley temple at its northwest corner, on the first floor. The valley temple was a large, almost square structure (42 x 42 m) with 12-13 m high walls, a T-shaped pillared room, storerooms and two entrances. Two roads, portions of which were cut in the bedrock, led up to them. An area (8.5 m wide) was cut and levelled in front of the temple and likely paved with limestone. The valley temple's core masonry was limestone, the floors travertine and the ceilings and walls, both external and internal, were cased in pink granite mostly, although black granodiorite was occasionally employed. A number of finer architectural details, such as lintels, steps and columns were also made in pink granite and 14 square pillars (1.05 m) and two rectangular ones (1.58 x 1.05 m) were made of monolithic blocks of granite embedded deeply into the floor (Maragioglio and Rinaldi 1966: 78); twenty three to twenty six gneiss, travertine and greywacke statues (with bases 1.1 x 0.6 m) were also placed in the pillared chamber (Maragioglio and Rinaldi 1966: 80). The granite blocks used for the casing vary in size. Unlike the temple's limestone masonry, the larger blocks were placed at the bottom, which increased the cohesion of the casing. The finished blocks are estimated to weigh 38-42 tons on average, which is less than the largest limestone blocks (Hölscher 1912: 52). In many cases, the limestone was cut to receive the granite casing (Maragioglio and Rinaldi 1966: 78). The sides of the granite blocks that came into contact with others were smoothed off and often cut again to fit together better (Petrie 1883: 132). The visible faces were polished, once the blocks were in place, and at times, considerable amounts of material were removed during this finishing stage, so that a number of corner blocks were actually transformed into L-shaped blocks (Petrie 1883: 132.). The granite slabs framing the two entrances were inscribed with hieroglyphs, which required a high degree of expertise (Hölscher 1912: 17).

Material Characterisation

Limestone is the main material used for Khafre's RMC. As with Khufu's, it was used for the masonry throughout the entire complex and also reworked for levelling, and the stepped-core, foundations and internal apartment. In addition it was also used in massive foundation platforms for portions of the mortuary temple and causeway. The limestone is the same grey-yellow nummulitic one used for Khufu's RMC. While a lot of the blocks were obtained from levelling the plateau, the rest came from a quarry 530 m southeast of the pyramid, heaved up with ramps made from working debris; the causeway may have originally been one of these ramps (Lehner 1985b: 151; Klemm and Klemm 2008: 45). While the bulk of the limestone was used for the pyramid, representing about two thirds of its volume, the majority consisted of unsquared blocks of varying dimension, irregularly laid, using rubble and no mortar, showing little care, as with Khufu's (Lehner 2002). Compared to Khufu's and Djedefre's, the internal apartments are simple and required shallow rock-cutting in open trench methods. Perhaps the most labour intensive feature were the burial chamber beams. Although portions of the valley temple and pyramid core were formed by shaping the bedrock, reducing the number of masonry blocks required (Maragioglio and Rinaldi 1966: 76), some of the blocks used in the valley and mortuary temple are the largest ever recorded;

the maximum known weight of such a block from this monument is 425 tons, weighing on average 150-180 tons; most are on the large side compared to those in other monuments (Hölscher 1912: 40). Still, it is interesting that the larger blocks were not used to form the lowest courses, but were positioned at different heights throughout the structures, which is not structurally ideal (Maragioglio and Rinaldi 1966: 76). Again, this points to the role of substantial manpower, but not necessarily high skill. Altogether, the limestone work, apart from the burial chamber ceiling, required considerable amounts of manpower but not much skill.

Fine limestone was used for most of the pyramid's casing and backing stone and the upper sections of the mortuary temple's outer casing. The casing is extremely well executed and was clearly carried out by specialists; 90% of the pyramid casing is of a uniform white-grey limestone that comes from a well-defined area, single quarry of the Tura-Maasara zone (Klemm and Klemm 2010: 95). The Tura-Maasara quarries are almost directly opposite Giza on the east bank, and stones would have been transported 16-18 km across the valley to the harbour near the valley temple and then to the southern supply ramp over a distance of 600 m. Given the immediate proximity of the quarries, it is surprising that, unlike his father Khufu's RMC, more stone was not used. Perhaps this can be explained in the light of Khafre's consumption of travertine.

For the first time since Djoser, travertine was used in an RMC, and at a much grander scale, with an increase in overall volume and unit size. Travertine was used for the floor of Khafre's valley and mortuary temples, and walls of one of his mortuary temple's storerooms; fragments of travertine indicate it was used for statuary. The stone was either transported 315 km downstream from the main OK quarry at Hatnub to Giza, or 40 km downstream from Wadi Gerrawi, south of the Tura-Maasara quarries, to Giza, where the stone was then transported over a minimum distance of 600 m to the valley temple. About half of it was then transported another 500 m uphill to the mortuary temple. As with the Tura limestone, the quarrying and transportation of travertine was something that could be achieved all year around. As mentioned in Chapter 6 (see section 6.1) travertine and harder varieties of limestone share many similarities. One could argue this especially in the case of the travertine from the Wadi Gerrawi quarries and the fine limestone from the Tura-Maasara quarries. Given the lack of fine limestone features, aside from the pyramid and mortuary temple casing, and the similarities in working properties between travertine and fine limestone and the proximity of the Wadi

Gerrawi and Tura limestone quarries, it is possible that some of the workforce previously devoted to the extraction and working of fine limestone was redirected in Khafre's reign to cover the consumption of travertine for architectural purposes, as visible in his RMC, as well as facilitating the use of this material for stone vessels and statuary. The fact that the stone was the standard material usually employed for vessels and a common choice for funerary furniture may have provided the impetus for considering its use in architecture (Reisner 1931: 139; Aston 1994: 47).

With an estimated 17,000 m^3, Khafre is considered the greatest consumer of granite of the OK (Röder 1965: 550-1). Internally, granite was used to pave the area around his sarcophagus, line the walls of the masonry portion of his pyramid's upper entrance corridor, the walls and ceiling of his mortuary temple, the lower sections of the walls of his causeway and the walls and ceiling of his valley temple. In addition, granite was employed for most of the finer architectural details of the RMC, ranging from small units like portcullises, doorjambs and steps, to 32 monolithic columns. Externally, granite cased the entirety of the external walls of the valley temple, and of the lower portion of his mortuary temple and pyramid. While the size of the units of granite used in Khafre's RMC varies, the finished blocks in his valley temple were massive, weighing in average 38-42 tons (Hölscher 1912: 52). If the final, finished units placed in the RMC represent only 30-40% of the total mass of stone (Röder 1965: 483-4), the original units transported to site would have weighed on average 133 tons each, which remains lighter than the blocks of limestone quarried locally, understandably, given the distance they were transported, and the overall volume consumed for the RMC. Granite had to be brought more than 700 km from Aswan, downstream, after which it was transported over 600 m from harbour to valley temple and 500 m up to the mortuary temple, which is less than that for Djedefre's RMC.

Except for a few outer casing blocks in the valley temple, all granite units are polished, which is the most labour intensive, but least skill-requiring task. The L-shaped corner blocks in Khafre's mortuary temple indicate that in some cases at least, such as the mortuary temple's walls, much of the stones' mass was removed by pounding the blocks *in situ* and that, unlike with Djedefre's pyramid casing, polishing was carried out once the unit was in place. Therefore, it is important to note that workmen were moving considerably larger units of granite than those visible in the final structure. Also, unlike the limestone blocks in the valley temple, the larger units of granite were placed at the bottom with smaller ones on top, which shows that some level of masonry logic and hence possibly expertise was likely present when the stones were being set. Skilled workers would have shaped the granite casing and unskilled workers polished, bearing in mind that battering for casing is a specialist skill that was made much harder with granite. Additionally, a handful of specialists sawed, drilled and carved the sarcophagus and holes in doorjambs, as discussed in section 8.2. Sawing added an extra stage before the stone's placement in the structure. However, drilling and carving, like polishing, may have been done once the unit was in place. An incised block of granite was found in the valley temple. The consumption of granite in Khafre's RMC is remarkable for its overall volume, but also because it called for the transportation and placement of much larger units than those visible in their finished form across the monument, and this perhaps more so for his use of granite compared to other earlier RMCs, though this would require further research. Hence, Khafre's granite consumption required the use of both large groups of unskilled workers and perhaps smaller groups of specialist workers to get the degree of finish visible. As such, granite is highly labour intensive material (Lehner 1985a: 152). The major deployment of granite in Khafre's valley temple and only partial use of the stone for the upper portion of his RMC may point to a desire to minimise the transportation of granite onto the plateau, as the majority of the granite was left at the floodplain level. If granite could only be transported during the inundation, Khafre's consumption of RMC is even more spectacular.

Khafre's granite consumption is additionally notable considering he also used granodiorite, which is attested for the first time in an OK RMC. Small units of granodiorite were used for the internal casing of the valley temple (Petrie 1883: 129-32) and possibly elsewhere, such as in the causeway and mortuary temple where most of the granite is now missing. A large block of granodiorite was shaped into his sarcophagus, which would have been made early on as it would have been placed early in the RMC's construction, after the burial chamber's trench was cut, but before the pyramid core masonry was laid. Granodiorite is much more valuable than pink granite, as it is rarer, harder to extract and more difficult to work, due to its tighter grain (Klemm and Klemm 2001: 636). The limited supply and increased technical demands may explain why it was used for the king's sarcophagus, but also in what seems like a rather haphazard way in the valley temple, as part of a predominantly pink granite wall lining. Perhaps it was still thought better to include a more precious variety of the hard stone, even idiosyncratically, rather than not at all.

Six life-size statues made of gneiss were found in Khafre's valley temple (Borchardt 1911: 9-14). This stone was brought over 1,000 km from Gebel el-Asr, south of Aswan in the Nubian desert, downstream to Giza where the stone faced the same local transportation requirements as other materials brought to site (please refer to section 6.1 for the technical demands imposed by gneiss).

8.5. Nebka

As discussed in Chapter 2, on the basis of a detailed assessment of the architectural design of the unfinished RMC known as the Great Pit at Zawyet el-Aryan, the granite consumption visible there, the name retrieved, and the gaps left in the later chronologies lead to the view taken here, which is that one of Djedefre's sons succeeded Khafre and started his RMC at Zawyet el-Aryan (see section 2.4; Lauer 1963; Maragioglio and Rinaldi 1963: 16, 22-4; von Beckerath 1997; Valloggia 1997: 132). As mentioned, a name, though difficult to read, was found inscribed in a cartouche on several blocks at the site. While different reconstructions give the different names, Nebka is preferred here (Maspero 1906: 17; Maragioglio and Rinaldi 1962: 16). Very little remains of the RMC that was abandoned at a very early stage of construction and is now off-limits on a military base. Barsanti (1906, 1907, 1912) carried out excavations, but was unsystematic in his recording (Maragioglio and Rinaldi 1962: 16). Maragioglio and Rinaldi surveyed the site (1962), and cut a few test trenches, identifying the remains of the perimeter wall and pyramid with an inverted T-shaped substructure. The available evidence suggests a design very similar to Djedefre's at Abu Rawash, but no other structure, such as a valley temple or causeway, has so far been identified and may never have been built.

Location and Layout

Zawyet el-Aryan is 5 km south of and upstream from Giza and hence slightly closer to the capital (10 km; figs. 8.7.1-8.7.3). The pyramid was built 1.2 km north of an earlier unfinished 3rd dynasty RMC known as the Layer Pyramid (see section 7.3), which is the closest known RMC. Yet, the closest, completed and most visible monuments were Khufu and Khafre's 5 km north at Giza (see tables 9.2, 9.4.). Djoser's step pyramid would have been visible 10 km south, by the capital, and Snefru's two pyramids at

Dahshur, 15 km south. The Zawyet el-Aryan monument marks a point mid-way between Djedefre's pyramid to the north at Abu Rawash and Snefru's to the south at Dahshur. While the pyramid site shares many similarities with Djedefre's at Abu Rawash – something returned to in section 9.1 of the following chapter – it is at a much lower elevation (25 m), closer (125 m) to the edge of a much less dramatic escarpment, which consists of moderately steep cliff (22 m) and of the main wadi entrance to the north-east and Nile River (500 m and 1.2 km respectively). The bedrock, which consists of a marly limestone that belongs to the Saqqara Member of the Upper Eocene formation, is of a good quality (Klemm and Klemm 2010: 36). The desert surface was relatively uneven, requiring preparation work, as discussed below.

The pyramid (200 x 200 m), had it been completed, would have reached 209-214 m in height (with casing), which is much larger than Djedefre's at Abu Rawash, though slightly less than Snefru's or Khufu's at Dahshur and Giza respectively (see tables 9.5, 9.6, 9.7; Maragioglio and Rinaldi 1962: 18). The bedrock was levelled by cutting protrusions and filling in depressions with blocks. A foundation platform, the two lowest courses of which are still in place, was made of limestone blocks 0.6-0.7 m high; some of the blocks weighed up to 3-4 tons and bore masons' marks painted in red (Barsanti 1906: 264-5). The bedrock around the pyramid's base was prepared to receive the casing (Maragioglio and Rinaldi 1962: 18). The internal apartment, consisting of a descending corridor (110 x 8.5 m) leading to an east-west running pit (25 x 12 m, 21 m deep) is identical to Djedefre's at Abu Rawash, though slightly larger (Barsanti 1907: 202). Steps were cut either sides of the descending corridor for the builders' movement and the centre kept smooth to facilitate the transport of materials (Barsanti 1907: 202). As at Abu Rawash, a platform (4.5 m thick) formed of three courses of fine limestone and possibly granite at the southern end was built in a deep trench at the bottom of the descent (Barsanti 1906: 283); the blocks were extremely well articulated (Barsanti 1907: 204; Valloggia 1997: 132). The walls of the pit are smooth and have a significant batter (unspecified in reports; Valloggia 1997: 132). Two courses of fine limestone blocks line the lower sections of the walls, and most likely cased a large portion of the chamber(s), and, as at Abu Rawash, were extremely finely articulated (Barsanti 1907: 203; Maragioglio and Rinaldi 1962: 20). The central portion of the floor at least was paved with three courses of pink granite blocks that vary in dimension but are on average 1 m thick, 3-4 m long and weigh 30-45 tons (Barsanti 1905: 263-82; 1912: 59).

Part of the paving, especially the eastern section, was completed with extremely well articulated fine limestone blocks (Barsanti 1907: 203).

One of the granite blocks in the western part of the pit was hollowed out into an oval shape to a depth of 1 m and very finely polished (*poli à glace*; Barsanti 1906: 282-6). It is most likely the sarcophagus that was sunk into the floor, as was done with Khafre's and also probably with Djedefre's (Valloggia 1999). A finely crafted granite lid made of a different variety of granite was sealed to the sarcophagus with a strong mortar (Barsanti 1906: 286). The sarcophagus was found empty, but for a black residue that had left a mark 10 cm thick at the bottom. The sarcophagus was completely covered over and protected with a thick layer of clay and several blocks of well-laid limestone (Barsanti 1906: 282). About 4,200 m^2 of limestone blocks weighing 3-4 tons each were pushed into the pit from above to a height of 15 m. The sarcophagus' content, sealing and protecting, and the blocking of the pit with masonry, were probably all actions that were part of a ritual the tomb owner's successor carried out after the former's premature death, to mark the end of the building of the monument, and point to the sanctity of the structures, from the onset and despite its incompletion. The sealing of the sarcophagus is reminiscent of Sekhemkhet's at Saqqara (Maragioglio and Rinaldi 1962: 26).

Although no valley temple or causeway was found at Zawyet el-Aryan, Maragioglio and Rinaldi (1962: 18) noted that the terrain northeast of the pyramid would be ideal for a ramp and causeway, potentially indicating where these structures were to be built. The rectangular perimeter wall (420 x 465 m), with an east-west axis and the pyramid in its centre, was built with limestone (walls 2.1 m thick; Maragioglio and Rinaldi 1962: 14).

In addition to masons' marks, Barsanti (1906: 261) identified what he believed to be the remains of workmen's huts at the foot of a hill north of the complex. This has not been confirmed since. Along with bronze scissors, flints and water vessels, a green schist palette with the name of Djedefre was found inside one of the rooms (Barsanti 1906: 261).

Material Characterisation

Limestone, used for the enclosure and pyramid masonry, is the most conspicuous material at the site. Most of the limestone used for levelling the pyramid's core and building blocks were obtained from the excavation of the pit (Maragioglio and Rinaldi

1962: 24; Klemm and Klemm 2010: 36). However, some blocks are from a brown, sandy, fossil-rich limestone that belongs to the Kom el-Shellul formation of the early marine Pliocene quarried from a nearby group of hills (Klemm and Klemm 2010: 36); unfortunately the exact location was not given. Of significance is the evidence that the builders made use of the material from the excavation in addition to a nearby quarry, strategically combining the excavation of the substructure with the production of masonry blocks.

Both fine limestone and pink granite were also employed. The fine limestone was used for the platform at the bottom of the descent, and to line the walls of the pit. It was not tested compositionally, but given Zawyet el-Aryan's position near the Tura-Maasara quarry stretch, and the fact that all fine limestone was sourced from Tura-Maasara from Snefru's time onwards, it is probable that the fine limestone source was the gallery quarry at the Tura end of the stretch.

It is remarkable how much granite was already present at the site. Pink granite was used to line the floor of the pit and make the sarcophagus, which was extremely well polished; *poli à glace* is usually used to describe a reflective surface (Barsanti 1906: 282). Achieving this with granite is a remarkable feat in itself. The granite was transported c.700 km downstream from Aswan.

The wadi northeast of the structure would have been used to move building materials brought from off-site quarries, requiring much less effort than for Djedefre's RMC at Abu Rawash.

8.6. Menkaure

Menkaure, son of Khafre, and often considered Khafre's immediate successor actually ruled after the owner of the unfinished pyramid known as the Great Pit at Zawyet el-Aryan (see sections 2.4 and 8.5; Lauer 1962b). Though Menkaure is assigned 18 years of reign on the Turin Canon (Dodson and Hilton 2004), a reign of 26 years is more widely accepted (Bolshakov 1995). Menkaure, whose name means 'Eternal like the sun of Re' and whose pyramid was named 'Menkaure is divine', died before his RMC was completed. His successor took care of the task, enough to make it functional during the first year of the cattle count with mudbrick, as a memorial slab commemorates (Reisner 1931: 30, 72). Petrie (1883) excavated Menkaure's pyramid and Reisner (1931) the mortuary and valley temples, both of which were relatively well preserved compared to other such structures at other RMCs. Today the valley temple is entirely covered by sand. Of the causeway, only the foundations remain and are mostly visible near the mortuary temple. In addition to the Zawyet el-Aryan monuments, Menkaure's RMC represents the building process of an RMC frozen during construction, providing insights into the building sequence, material use and workforces that are particularly valuable when considered in conjunction with Shepseskaf's RMC at South Saqqara (see section 8.7 and 9.1).

Location and Layout

Menkaure returns to Giza 5 km north of Zawyet el-Aryan to build his RMC (figs. 2.17; 8.7.1-8.7.3). His pyramid, a few hundred meters southwest of Khafre's, is set further (500 m) into the desert than the other two Giza pyramids, probably due to local topography. Although Menkaure's pyramid is built at the same elevation as Khafre's (70 m), its reduced size makes the higher ground barely noticeable (see tables 9.2, 9.4.). From the north, the two other massive monuments dwarf it, completely obstructing it from viewers in the valley and the Delta. However, all three monuments are clearly visible from Saqqara and Zawyet el-Aryan in the south. The position of Menkaure's pyramid in front of the other two pyramids makes it seem larger than it is, suggesting that its size and placement responded to visibility from the capital (Jeffreys 1998, 2010). Menkaure's complex is c.1 km from the main local wadi entrance south of the necropolis, where his causeway and valley temple are unsuitably built, as the frequency with which the monument was repeatedly damaged by flash floods indicates (Butzer 2001a: 3); repairs to the mudbrick structures are attested as far back the OK (Reisner 1931: 48). The complex is 3 km west of the ancient river course which was connected to the site via a canal (Lutley and Bunbury 2008: 3-4). The desert surface, on which the upper section of the complex was built, is good quality but particularly uneven; most of the bedrock required levelling and the easternmost portion of his mortuary temple necessitated greater foundation work than Khafre's (see section 8.4). Menkaure's pyramid is the last to use a natural rock-knoll core.

The pyramid shows three successive phases of construction (Petrie 1883: 40). Initially it comparable to the Queens' pyramids on the Giza plateau and would have been incredibly small compared to earlier RMCs. A rock-cut corridor roofed with a long lintel led to a rock-cut chamber (see tables 9.5, 9.6, 9.7). The pyramid was enlarged before the casing was put into place, the chamber deepened, and the passage leading to the burial chamber cut. The new, deeper, burial chamber is part either of the second or third building phase. The old entrance was blocked up and a new passage built (Petrie 1883: 40). The final pyramid (102 x 104 m, 65 m high) is a quarter of the size of Khufu's and Khafre's, representing one tenth of the total volume of Khufu's and as such is similar to Djedefre's at Abu Rawash (Lehner 1997: 134). Typically for the Giza and Abu Rawash 4th dynasty RMCs, the pyramid was built by laying blocks of limestone around a rock-knoll, the dimensions of which are unknown. The lower 16 courses were cased with pink granite and the rest with fine limestone. Although this remains speculative, Reisner (1931: 30) suggests that the fine limestone was laid by Shepseskaf's workers in an initial, short-lived attempt to complete the complex, before deciding to shift to a more economical material, in this case, mudbrick, for the rest of the complex, and that the pyramid was meant to be clad in granite. The pink granite around the door was almost entirely dressed. The entrance corridor is lined with pink granite until the point where it is rock-cut. All the chambers are rock-cut. The walls of the first chamber are decorated with relief-panelled decoration, which is common in the earliest tombs in Egypt, but seen for the first time in a pyramid. The direction of the pick-marks indicates that the horizontal passage was worked from the inside out and workers accessed it via a tunnel in the second chamber's ceiling, which seems to be the standard approach to building, as other incomplete or mudbrick finished RMCs suggest.

The burial chamber, despite being rock-cut, is entirely lined with pink granite (Petrie 1883: 39). The ceiling consists of large blocks of granite forming an arch. The undersides were smoothed to form a curved, barrel-like form in a way that created a ceiling reminiscent of passages of the earliest rock-cut tombs (also seen in Sekhemkhet's RMC at Saqqara, see section 7.2; Petrie 1883: 40). The blocks were introduced via a special cut in the floor of the chamber above and manoeuvred into place within the tight confines of the chamber, which is in itself a feat, and an intriguing one given the construction logic noted at earlier sites whereby such large blocks were placed early on in the construction in open-trench-like chambers or above-ground masonry to facilitate access (i.e. Snefru, Khufu, Djedefre, Nebka). Steps led to six long and narrow rock-cut chambers, a feature unique to this RMC and the functions of which remain unknown. Petrie has suggested that they may have been intended to hold coffins (1883: 40).

The mortuary temple was started with large blocks of limestone and finished with mudbrick. Initially, the entrance corridor, open-court and northern corridor leading to the inner-temple were designed to be entirely cased in black granodiorite and the portico and outer offering room in pink granite. The mudbrick magazines were intended to be built/lined either in fine limestone and/or pink granite. The inner temple was built around a pink granite pavement and the walls were later built in fine limestone under Shepseskaf (Reisner 1931: 29). An initial attempt was made to complete the innermost chambers of the mortuary temple in fine limestone under Shepseskaf, but was soon abandoned in favour of a cheaper material, notably mudbrick (Reisner 1931: 30). The outer offering rooms and portico in fine limestone were so near completion that little mudbrick was used. However, the entrance corridor, open-court, north corridor and abutting areas north and south – as well as a number of freestanding walls and the exterior of the temple – were built in mudbrick, often covering the limestone and granite blocks, probably to give the structure a homogenous feel. The mudbrick was then coated with a heavy yellowish plaster and whitewashed.

It is not clear to what degree the causeway (608 m long) was completed. Foundations made of limestone blocks were built as a continuation of the mortuary temple. The upper portion abutting the mortuary temple consisted of mudbrick walls coated in white plaster with a ceiling made of wood logs (Reisner 1931: 25). The valley temple, which was built on an unfinished limestone platform resting on gravel alluvium, extends under most of the inner temple and the northern section of the open-court; it was started under Menkaure, with large blocks of limestone identical in dimension to those of the mortuary temple and causeway, and finished with mudbrick under Shepseskaf. The limestone masonry walls were started near the causeway, and blocks of limestone, brought down from the quarry to the temple by means of the causeway acting as a ramp, were laid from west to east. The valley temple was abandoned at an earlier stage of construction than the mortuary temple, which indicates that the valley temple was started later (Reisner 1931: 39).

Material Characterisation

Approximately 250,000 m^3, or 630,000 tons, of limestone blocks (weighing in average 29 tons) were quarried and used for the masonry and foundation platforms, a quantity that clearly exceeds that of any other building material used in Menkaure's complex. In keeping with the Giza tradition, the main quarry was extremely close to the building site, just 300 m south of the complex. In addition to the limestone masonry, the bedrock was integrated into the design of the monument, an essential tactic given a significant proportion of Menkaure's pyramid was granite casing as it provide greater stability for the weightier stone. Approximately 11,000 m^3 of limestone was cut for the foundation of the mortuary temple. The amount of work required for the foundations alone, and unsuitable placement of valley temple and causeway in the wadi, strongly suggests that other factors overrode topographical considerations for Menkaure's RMC.

Mudbrick was used to complete Menkaure's complex after his death, but was not part of the original design. It was used for the valley temple, causeway, mortuary temple and perimeter wall. The bricks used under Menkaure could not be tested, but are described as coarse and crude, whereas those used by Shepseskaf's as "darker and more uniform in consistency" (Reisner 1931: 39; Maragioglio and Rinaldi 1964: 60). This suggests that the few used during Menkaure's reign were lighter and lacked uniformity, indicative of a different strategy from Shepseskaf's usage. Given the amount of bricks used for the workmen's settlement at Giza, the material would have been readily available. Although at the limit of what we can infer from the evidence, the difference in bricks suggests a more centralised production for the larger volumes required under Shepseskaf compared to the small volume required under Menkaure.

The walls of the inner enclosure, causeway and valley temple walls have either completely disappeared, or are very eroded, which makes it very difficult to know the original height or to estimate the volume of material used. To help deal with this issue, two volumetric estimates are provided to give a lower and upper range; the first is based on a 3 m high wall and the upper one is based on 6 m height based on Maragioglio and Rinaldi (1967). Between 30,000 and 50,000 m^3 of mudbrick were used for the enclosure wall, causeway, mortuary and valley temple. The estimate would be even higher had the calculations included the mudbrick used for the queens' tombs and the satellite pyramid. However, the maximum number of workers given in the chart seems high compared to ethnographic parallels in Egypt (Engel 2008; Friedman, pers. com. 2008) and recent studies done on the ED mudbrick royal tombs (Engel 2008: 33) give numbers between 30-40 workers. Therefore, based on the lower-ranging estimates, it would have taken four or seven years to complete the complex with mudbrick, depending on the volume used, and as little as eight months with 500 workers, or 16 months with 250, a time estimate closer to that which is given by the commemorative plate found in the mortuary temple. The following Table 8.2 gives three different estimates for the amount of days a crew of 50, 100 and 500 workers would have taken to complete the amount of brick work at Menkaure's complex. The numbers are estimates based on data supplied by Pollock (1999: 180) for her study of the Mesopotamian workforce employed for monumental mudbrick structures, and gives a lower and upper range for the volume of mudbrick consumed for Menkaure's RMC (in this case excluding the queens' pyramids and satellite pyramid). The volumes are in cubic meters.

		Days to Construct with:		
Volume	*Person-days labour*	*50 labourers*	*100 labourers*	*500 labourers*
30, 000	75, 000	1, 500	750	150
50, 000	125, 000	2, 500	1, 250	250

Table 8.2 Estimates for Mudbrick Production at Menkaure's RMC

The mudbrick finish suggests the workforce quarrying local limestone was busy elsewhere, notably at South Saqqara/Dahshur for Shepseskaf's own mortuary complex (see following section 8.7) 17 km south of Giza. Like limestone, mudbrick is a local material that can be produced near or at the site. However, building in limestone requires more man-hours. Therefore mudbrick is useful for a hasty completion (Reisner 1931: 39; Maragioglio and Rinaldi 1967: 66-7).

With an estimated c.16,500 m^3, or 45,000 tons, of *dressed* granite used for Menkaure's RMC, it remains the most conspicuous hard stone used in Menkaure's RMC, and had his RMC been finished as planned, it would have employed the most granite of all OK RMCs (Bloxam 2004: 143). Granite was used to case the lower 16 courses of the pyramid, which is four courses less than Djedefre's and 14 more than Khafre's. It was also used to line the first 4 m of the masonry portion of the pyramid's entrance corridor; the entirety of the corridor leading to the burial chamber and the chamber's floor, walls and ceiling; and granite was used to line the walls inside the mortuary temple, for which both pink and black granite (granodiorite) were used. It is unclear whether the sarcophagus is black granite or greywacke. A granite lintel was also found in the south doorway passage of first chamber. While granite represents only 5% of the estimated total of building materials, it represents c.50% of materials used for finer architectural details such as casing, lining etc, which is only a little more than what can be determined with the available evidence for fine limestone. Since a roughly dressed block of granite represents only about 30% of the total amount of granite extracted (Röder 1965: 482-4), the quantity of granite used for Menkaure's complex is much greater than traditionally thought, and may be estimated at 76,500 metric tons, or ca. 28,000 m^3. The granite blocks were transported 700 km downstream from the Aswan, roughly dressed. The fact that the polishing on Menkaure's granite casing was started, but never completed could further support the case of polishing being a specialist task or one requiring constant supervision by specialists. Workers started on the east and north faces of the pyramid, rather than corners (Petrie 1883: 110; Maragioglio and Rinaldi 1964: 36). They chose the sides that faced the rest of the site and that received the most ritual attention (entrance and mortuary temple). That the polishing was *not* done simultaneously on all four sides of the pyramid suggests that only a limited number of workers were available for this task. The use of granite in Menkaure's RMC was very similar to Khafre's and represents the second largest consumption of granite after Khafre's.

It is estimated that only 5% of the finer architectural features of Menkaure's complex was made of fine limestone, which is much less compared to previous RMCs. Although no fine limestone casing was recovered *in situ*, broken fragments found in the debris at the foot of the pyramid indicate that the stone was used to case the upper portion of the pyramid (Petrie 1883: 110; Maragioglio and Rinaldi 1964: 34). While this may show a deliberate trend in the design and/or construction of the monument, the frequent reuse of fine limestone, due to its fine grain and the fact that it is easier to break down and carry away than basalt or granite, may explain the noted pattern. It is estimated that a minimum of 16,000 m^3, or about 40,600 metric tons was consumed and transported downstream from his quarry at Tura-Maasara to Giza. The use of fine limestone calls for much less loss of material than harder stones such as granite; limestone is easier to quarry and dress because it is relatively soft; its sources are also closer to the building site and perennially available (*a contra* granite and basalt). It also most likely had its specialist craftsmen in the region.

Other stone, such as Chephren Gneiss and travertine, were also used in Menkaure's complex for statuary and stone vessels (Bevan 2007: 70-1). Menkaure did not use any basalt in construction; only 4% of the recovered stone vessels found in his complex were made of basalt (57% were travertine).

8.7. Shepseskaf

Shepseskaf, son and successor of Menkaure, was considered in later king lists the last king of the 4th dynasty. Shepseskaf returned to Saqqara for his RMC, which he ~~placed~~ south of the Saqqara plateau where Djoser and Sekhemkhet had their RMCs built to extend the earlier royal necropolis south (figs. 2.17, 8.9.1-8.8.9.). Shepseskaf had a short reign; Manetho assigns him seven years and the Turin Canon four. Within the span of his short reign, Shepseskaf was responsible for the construction of a much smaller RMC and the completion of his father's RMC at Giza during the first year of his reign. Shepseskaf, which means 'His Soul (or Body) is Noble' and whose pyramid was named 'Shepseskaf is Purified' (Verner 2001: 254), broke the royal funerary tradition by building a stone mastaba instead of a pyramid. This gave the complex its name, Mastaba Faraun; and it did not have a followers' cemetery. However, the overall layout of his RMC retained all the traditional features of a 4th dynasty RMC and the layout of his internal apartments actually set the norm for all subsequent OK royal tombs (Goedicke 2000: 405). Vyse and Perring (1840), Mariette (1884: 361-5) and Lepsius (1943) give brief descriptions of the monument, but Jéquier (1928) carried out the first and only systematic excavation of the RMC. Maragioglio and Rinaldi's (1967) survey work provides additional information on the complex.

Location and Layout

Shepseskaf started a new royal necropolis south of the 2nd and 3rd dynasty royal necropolis, which can be seen as extending the ancestral cemetery at Saqqara. The RMC, while c.3.5 km south of the presumed original location of the capital, may have been aligned with its new location further south due to a shift of the Nile (Malek 1997). It may be significant that Shepseskaf did not only return to an older form and cemetery, but his RMC is also almost equidistant from Djoser's RMC north at Saqqara and Snefru's North Pyramid south at Dahshur (3.6 km and 3.5 km respectively). Both kings were considered later in Egyptian history as the founders of the 3rd and 4th dynasties respectively (see tables 9.2, 9.4.). Shepseskaf's complex is built just south of Wadi

Tafla, which naturally delimits the Saqqara necropolis' southern boundary; the entrance to the necropolis is 1 km to the northeast. The RMC stands at a relatively low elevation (27 m) and far (800 m) from the edge of the escarpment, which consists of a medium-rising slope (22 m). The Nile River was 1.8 km east (Lutley and Bunbury 2008: 5). The desert surface is even and consists of a marly limestone (Klemm and Klemm 2010: 109) that is moderate to poor in quality. The nature of terrain required artificial foundations to be built and may explain in part the reduced scale of the superstructure (Jéquier 1928: 3-4; Maragioglio and Rinaldi 1967: 136).

The tomb superstructure is a large rectangular stone structure (99.6 x 74.4 m) with a north-south axis; the top of the north and south walls are slightly higher (3 m) than the east and west ones, giving the structure a shape that is reminiscent of an OK sarcophagus (Lepsius 1849) or house (Jéquier 1928), but more commonly compared to a mastaba. As with Snefru's North Pyramid at Dahshur (the two sites share a common geology), the superstructure rested upon a platform sunk to a depth of 2.5 m in the ground and was made of large and roughly squared blocks of local limestone framed with fine limestone reaching up to 0.5 m below the ground surface (see tables 9.5, 9.6, 9.7). The platform appears to have been restricted to certain portions of the superstructure (Maragioglio and Rinaldi 167: 136). The superstructure is built with two steps, five courses high that were invisible once the casing was set. The masonry is similar to that of the Giza pyramids, consisting of blocks of relatively well-cut local limestone, comparable in their large dimension to those used at Giza (2.5 x 1.5 x 1.0 m; Klemm and Klemm 2010: 108), well laid to a depth of 6-7 m into the monument, around a rubble core (Maragiglio and Rinaldi 1967: 138). Construction debris cemented the space between the masonry and casing with mortar fill (Jéquier 1928: 7-8). The casing's first course at least was made of pink granite, the rest fine limestone (Jéquier 1928: 10-1). The top was cased with fine limestone shaped to form a north-south running barrel vault (Maragioglio and Rinaldi 1967: 138). The fine limestone, of which few traces remain, was also used for the superstructure's backing stones. Large circular holes near the northwest and northeast corners may have been dug for foundation deposits (Maragioglio and Rinaldi 1967: 138).

The internal apartments were built in a similar manner to Djedefre's at Abu Rawash and the Great Pit at Zawyet el-Aryan, but at a reduced scale. They consist of an inverted T-shaped open trench cut into the bedrock to a maximum depth of 7-9.5 m with, in this case, an additional trench running north-south to the south for magazines (Maragioglio and Rinaldi 1967: 150-2). The internal apartment is built with fine limestone blocks a height of 6-7 m above ground. The space between the masonry and edge of the trench was filled with limestone. The majority of the substructure walls and ceilings are made of pink granite (Maragioglio and Rinaldi 1967: 136). The blocks are at times very large and generally well squared, dressed and laid. A few blocks near the entrance are of black granodiorite. The entrance corridor leads to an antechamber (22 x 7-8 m), which gives access to a burial chamber (7.78 x 3.90 m) to the east and magazines to the south (Maragioglio and Rinaldi 1967: 140). The burial chamber is entirely cased in granite. Blocks are cut so that no cement was necessary; they are roughly finished and were left unpolished. The ceiling is formed of seven beams (1.05-1.45 m wide) the underside of which is curved, as in Menkaure's burial chamber (Jéquier 1928: 5-6). The sarcophagus, of which only fragments remain, was finely executed and made of greywacke from the Wadi Hammamat similar in style to Menkaure's (Klemm and Klemm 2010: 111). The magazine's ceiling is made of seven slabs of granite (0.80-1.60 m wide) to the north and eight (0.48-1.27 m) to the south. Three granite portcullises were found.

The degree of destruction and amount of material removed from the east chapel make it difficult to reconstruct the original plan. Still, it is possible to tell that the chapel consisted of two main sections: a paved courtyard, representing more than half the chapel's surface, with a chapel to the west abutting the mastaba surrounded by a brick wall (Jéquier 1928: 14). While the mastaba foundation platform extends east under the westernmost part of the temple, the rest of the temple walls were all built on specifically laid foundations formed with blocks of local and fine limestone (Maragioglio and Rinaldi 1967: 144). The floors that are paved with slabs of limestone were laid on a mixture of mud and stone chippings. The wider stonewalls were formed with two rows of masonry and infilled with rubble (Maragioglio and Rinaldi 1967: 144). The base of the outer walls, and possibly some internal ones too, were cased with pink granite (with blocks 1m high) and the upper portion with fine white limestone, continuing the mastaba's external casing (Maragioglio and Rinaldi 1967: 13). The mudbrick wall that surrounds the courtyard is thick and coated with the brownish yellow plaster typical of the 4th mudbrick structures; sections of it were decorated with the palace-faced motif. Interestingly, the decoration pattern is similar to the polishing patterns of Menkaure's granite pyramid casing in that the north wall presents the most complete palace-façade motif, while the south and east walls were less elaborately decorated. From this, Jéquier

(1928: 17-8) supposes the walls had different value and follow an order dictated by religious norm. It could also reflect the main direction from which the RMC would be most commonly viewed; for both, the north makes most sense.

The two perimeter walls (3.3 m high and 2 m wide at the base) were made with mudbricks (laid in rows of alternating headers and stretchers), with a batter and bevelled tops. The inner wall is, as is customary, 10 m from the tomb, and coated with a dark coloured mud-plaster (Maragioglio and Rinaldi 1967: 148). The second wall, which is badly preserved and 48 m from the tomb, is coated with the typical 4th dynasty brownish-yellow plaster (Jéquier 1928: 17-8). The causeway (est. 760 m long, 1.70 m wide, 3 m high with walls were 1.20 m thick) is built with mudbrick and had a vaulted roof. It is much simpler in design than earlier ones, and does not match the quality of the tomb, being the only feature that shows a certain degree of haste in its execution, probably at the king's death (Maragioglio and Rinaldi 1967: 150). Gaps were left in the walls during the construction and filled in later, possibly to allow for the movement of workers. There are no traces of a valley temple. Although remains of columns were found, they could be of a later date, as there is a good deal of 6th dynasty activity in this area. Similar to Menkaure's RMC, the more profane areas furthest east from the pyramid were built using more vernacular materials, i.e. mudbrick.

Material Characterisation

Limestone, which was used for the foundation platform and masonry of the superstructure and the mortuary temple, as well as for the chapel pavement, is the most conspicuously used material on-site. The limestone, which is relatively porous and ranges from a reddish-brown calcareous sandstone to a sandy shell-rich limestone belonging to the same Kom el-Shellul formation used at Dahshur North, is not of a very good quality (Klemm and Klemm 2010: 109). It came from a quarry that is now off-limits because it is in a military zone in a low mountain range, 2.3 km to the southwest, a distance much greater than all other local limestone quarries used in the 3rd and 4th dynasty. The quarry is clearly identifiable thanks to the presence of a large drag ramp departing from the southwest corner of the RMCs and that was once paved (Jécquier 1928: 7, fn. 1; Klemm and Klemm 2010: 108-9). Jécquier (1928: 7, fn. 1) estimated that 200,000 m^3 of stone was quarried away. Another road heading south and that lost itself in the desert was originally noted, though it is not clear if it led to a quarry (Maragioglio and Rinaldi 1967: 150).

Though hard to estimate given the poor state of preservation, mudbrick may have been the second most conspicuously used material on site. It was used for the eastern-most features, notably-the two perimeter walls, the open-court's surrounding and the causeway; and although this cannot be proven, mudbrick was probably also used in the valley temple. The bricks used for the wall of the open court are of a standard 4th dynasty size (31 x 15 x 8 cm). Though their composition could not be tested, they are described in reports as varied in composition and as containing little chaff (Maragioglio and Rinaldi 1967: 146).

Fine limestone was used for most of the masonry of the internal apartments, and the casing of the superstructure foundation platform and the upper portion of the superstructure's casing. Petrographic analysis determined that the limestone was sourced from a large gallery quarry situated next to the current Tura cement factory (Klemm and Klemm 2010: 111), which entailed bringing the stone 12 km upstream to a harbour associated with the valley temples near the wadi mouth.

The lower courses of the superstructure's outer casing and almost all of the tomb's internal apartments were lined with granite. A number of lintels and doorjambs in the mortuary chapel appear to have also been made of granite (Maragioglio and Rinaldi 1967: 146). Although it is unknown whether black granodiorite was used for architectural purposes or objects, such as statuary, fragments were found near the entrance. Although polishing was unfinished in the burial chamber, granite is well-crafted across Shepseskaf's RMC. The builders, probably specialists, left Menkaure's complex immediately following the coronation to come to work in Shepseskaf's RMC.

The overall design and consumption of granite and fine limestone for Shepseskaf is particularly significant as he oversaw the completion of his predecessor Menkaure's complex at Giza and will be returned to in the following chapter (see section 9.1).

8.8. Summary

Snefru's building projects stand out from other OK ones in many ways. They emphasise the region south of the capital, including his likely predecessor(s)'s monuments at

Meydum and Seila (MSP). They represent the largest consumption of limestone (Stadelmann 1980) and the integration of phyles into the workforce, as discussed in Chapter 2 (Roth 1991: 119-20). They also introduced the first large-scale consumption of an off-site material: fine limestone from Tura-Maasara. The use of the latter stone was retained for all subsequent RMCs, which shifted the bulk of material consumption from a local to a regional scope for the first time. While local availability of both soft and hard limestone was a prerequisite for siting of earlier RMCs, it no longer needed to be, and this shifted the overall monumental calculus in interesting ways, as we shall see (section 9.1). Snefru's building required for the first time important organisational skills for the sheer volume of materials involved and both on- and off-site management, with the number, placement and material choice (source) having important implications for the workforce. Khufu moved the project north to Giza to a site offering an ideal spot for the type of projects now envisaged, removing many of the logistical difficulties his father faced at Dahshur and possibly significantly marking the end of monument placement south of the capital, something returned to in section 9.1. Khufu also expands the breadth of bulk material acquisition instigated by his father to include harder material from further afield. While the use of basalt is abandoned until the 5th dynasty, bulk consumption of granite is retained for all subsequent RMCs and explodes with the Giza RMCs, something returned to in the following chapter. Djedefre moved to Abu Rawash, a site downstream from Giza that provided quality material and elevation, two factors which may have made up for the reduced scale of the pyramid and the overall simpler material design that required much less work than his father's at Giza. Immediately building on his father's granite consumption, granite is made to be outwardly visible to all because of the number of courses used and accentuated by the pyramid's elevation.

Khafre breaks the tradition set by Khaba in the 3rd dynasty in which each king created a new royal necropolis by returning to his father's cemetery at Giza. The design of his RMC echoes the lavish one of his father's, especially the refined material orchestration. Khafre's consumption of granite remains unparalleled. Khafre also introduces the use of travertine in architecture.

If the placement of the unfinished RMC at Zawyet el-Aryan, known as the Great Pit, proposed in this study is correct, the monument, despite premature abandonment, appears to share interesting similarities with Djedefre's. The owner, like Djedefre, left

Giza to choose a location nearby (5 km), and his RMC has a similar design. Despite the pyramid being bigger than Djedefre's, given the local topography, the causeway would never have reached the monumental proportions of Djedefre's, possibly showing a reverse relation. The Great Pit at Zawyet el-Aryan also provides valuable evidence that sheds light on a system of interdependence between projects, especially in the light of the two subsequent RMCs (Menkaure's and Shepseskaf's). Also, the degree of advancement of the internal structure in comparison to the rest of the RMC, in this case the pyramid core and the perimeter walls, brings to light the 'inside out' logic of the construction process of RMCs, showing priorities in construction.

Menkaure returned to Giza. His RMC, completed by his successor, is also a good example of RMC construction frozen in time. The fact that the use of stone in this RMC, first granite and then limestone, ceased when Menkaure died, provides a time-scheduling context for the work. It is interesting that the local topography was not ideal. One of the smallest pyramids is similar in dimension to the superstructure of Djedefre and his successor Shepseskaf at South Saqqara. It is interesting that Menkaure's RMC consumption of granite would have been the highest of all RMCs had it been finished as originally planned. It is also interesting that Menkaure's plan was for a smaller pyramid. The pyramid was modified before the RMC's completion, again providing insight into the logic and priorities of RMC construction. Also, like Djedefre, the pyramid's granite casing covered more of the surface than was covered in any other pyramid.

Shepseskaf leaves Giza for South Saqqara, ushering an age of capital-based RMCs (Abusir and South Saqqara). He is best known for his abandonment of the pyramid shape. Still, much in the design of his RMC continues previous norms and shows signs of skill and expertise with limited numbers of workers. While Shepseskaf's move is generally seen as ideological, moving away from the dominance of the sun cult, the move may in fact have been logistical, prompted by the retreat of the Nile east at Giza (Bunbury *et al.* 2009: 163). This left limited space available on the plateau to build another RMC. Yet Shepseskaf had a desire to be closer to the capital, which may then have already been undergoing a southern expansion (Malek 1997). It is also significant that mudbrick remained an important material for his RMC, but also those of his successors, until the end of the 4th dynasty. Khufu and Khafre's RMCs at Giza were the only exceptions.

The following chapter offers a thematic discussion of some of the possible logistical, social and ideological/symbolic implications of the locational and material trends brought to light in the last three Chapters 6, 7 and 8.

CHAPTER 9
MONUMENT BUILDING AS STATE BUILDING

This chapter returns to the main locational and material trends in Egyptian RMCs discussed in previous chapters, but this time considers them from several linked thematic perspectives. A summary of these main locational and material patterns is provided in tables 9.1-9.4 and 9.5-9.7. The discussion below is organised into three sections that consider respectively the logistical, symbolic and socio-political implications of the details noted in Chapters 5-7. I offer further insights into RMCs as indices of power, and I consider how their construction contributed to state consolidation as salient socio-political acts. Monumentalisation was achieved in a multitude of ways not just by sheer volume of material but through types of materials, locational choices and decision-making that balanced a range of logistical, symbolic and social priorities. The analysis below highlights an interesting interplay between place and material as well as a pattern of feedback between use of mudbrick and stone. I also show that RMC programs were interconnected, confirming the value of looking at RMCs in sequence as ongoing building projects.

9.1. RMC Building Logistics and State Consolidation

The choice of location and building materials for a monument has important implications for the logistics of construction, which can inform us about the extent of the political power of an individual ruler, and about a wider set of social implications. This part of the discussion focuses on the technological requirements associated with the consumption of different materials and the spatial deployment of task as a ground plan for understanding the social context of construction discussed in section 9.2. Over the chosen period, building logistics increased in scale and complexity, with a general expansion from a largely local to a truly national logistical scope in ways that permitted greater social integration. First, to make up for the lack of evidence we have for Khasekhemwy’s monuments and for a mudbrick workforce in general, it is worth revisiting Khasekhemwy’s building projects in greater detail.

Table 9.1. Locational setting of royal mortuary complexes from Khasekhemwy to Huni (I)

King	*Site*	*Coordinates Northing*	*Coordinates Easting*	*Distance to Immediate Predecessor (m)*	*Direction of Move*	*Closest RMC*	*Distance to Closest RMC (m)*	*Relationship to Owner*	*Distance to Capital (m)*	*Site Elevation (m)*	*Cliff Base Elevation (ASL)*	*Floodplain Elevation (ASL)*
Khasekhemwy	Abydos Tomb	26 10 22	31 54 28	245	S	Qaa	40	Last ruler of 1st dynasty	460,000	106	0	66
	Abydos Enclosure	31 54 28	31 54 28	8	S	Peribsen	8	Immediate predecessor	460,000	74	0	66
	Hierakonpo-lis	25 05 28	32 46 25	na	na	na	230,000	na	690,000	87	0	84
	Saqqara	29 51 59	32 46 25	470,000	N	Hotepsekehmwy	800	Founder of necropolis	900	45	22	20
Djoser	Saqqara	29 52 16	31 12 58	470,000	E	Hotepsekehmwy	100	Founder of necropolis	900	50	22	20
Sekhemkhet	Saqqara	29 51 57	31 12 47	350	SW	Djoser	330	Immediate predecessor	1,300	50	22	20
Khaba (?)	Zawyet el-Aryan	29 55 58	31 09 39	9,000	N	Djoser	9,000	Builder of 1st pyramid	9,000	50	22	20
Unknown (?)	Abu Rawash	30 02 22	31 05 44	14,000	N	Khaba	13,000	Immediate predecessor?	22,000	25	0	19
Huni (?)	Meydum	29 33 35	31 13 18	75,000	S	Djoser	54,000	Builder of 1st pyramid	54,200	27	24	24

Table 9.2. Locational setting of royal mortuary complexes from Snefru to Shepseskaf (I)

King	*Site*	*Coordinates Northing*	*Coordinates Easting*	*Distance to Immediate Predecessor (m)*	*Direction of Move*	*Closest RMC*	*Distance to Closest RMC (m)*	*Relationship to Owner*	*Distance to Capital (m)*	*Site Elevation (m)*	*Cliff Base Elevation (ASL)*	*Floodplain Elevation (ASL)*
Snefru	Meydum	29 33 35	31 13 18	0	na	Meydum E0	0	Immediate (?) predecessor	54,200	27	24	24
	Dahshur	29 47 24	31 12 32	45,000	N	Djoser, then North pyramid	9,000	Builder of 1st pyramid	9,300	50	22	20
	Dahshur	29 48 30	31 12 53	2,000	N	Bent pyramid	2,000	Himself	7,200	50	22	20
Khufu	Giza	29 58 53	31 07 49	20,000	N	Khaba	5,700	Immediate predecessor	14,800	61	30	19
Djedefre	Abu Rawash	30 01 54	31 04 50	8,000	N	Khufu	8,000	Father	23,000	150	70	18
Khafre	Giza	28 58 33	31 07 49	8,000	S	Khufu	450	Grandfather?	14,700	70	30	19
Nebka (?)	Zawyet el-Aryan	29 55 23	31 09 56	5,000	S	Khaba	1,200	Immediate (?) predecessor	9,500	25	22	20
Menkaure	Giza	29 59 20	31 07 40	5,000	S	Khafre	475	Father?	14,600	71	30	19
Shepseskaf	South Saqqara	29 50 20	31 12 54	17,000	S	Djoser	300	Predecessor	3,700	27	22	20

Table 9.3. Locational setting of royal mortuary complexes from Khasekhemwy to Huni (II)

King	*Site*	*Geology*	*Ground Quality*	*Foundation Type*	*Final Founda-tion Quality*	*Slope Type from Valley*	*Relief*	*Distance to Escarpment (m)*	*Distance to Wadi Entrance (m)*	*Dist. To Local Quarry (m)*	*Quarry Location*	*Dist. To Fine limestone Quarry (m)*	*Dist. To Lake or Canal (m)*	*Dist. To River (m)*
Khasekhemwy	Abydos Tomb	sandy gravel	moderate	unknown	unknown	low lying wadi fan	flat	150	1,000	unknown	na	na	unknown	unknown
	Abydos Enclosure	sandy gravel	moderate	compacted silt + sterile sand	good	low lying wadi fan	flat	500	3,000	na	na	na	unknown	unknown
	Hierakon-po-is	sandy gravel	moderate	compacted silt + sterile sand	good	low lying wadi fan	flat	100	1,000	na	na	na	unknown	<1,000
	Saqqara	marly limestone	moderate	trench for N & S wall	moderate	steep cliff; soft wide wadi	uneven desert surface	1,500	3,500 (1,300 small wadi)	150-1,500	N; E; poss W	<1,000	2,200	2,660
Djoser	Saqqara	marly limestone	moderate	1 course limestone	moderate	steep cliff; narrow wadi	uneven desert surface	750	1,500 (850 small wadi)	200-5,000	W; NW; E	<1,000	1,500	1,860
Sekhemkhet	Saqqara	marly limestone	moderate	limestone masonry platform 5.2 m	moderate	steep cliff; narrow wadi	uneven desert surface	830	2,100 (1,000 small wadi)	200-5,000	unknown	<1,000	2,300	2,000
Khaba (?)	Zawyet el-Aryan	marly limestone	moderate to poor	natural bedrock	moderate to poor	steep cliff, narrow wadi	uneven desert surface	110	600 (60 small wadi)	150-200	E	<1,000	unknown	1,000
Unknown (?)	Abu Rawash	limestone + alluvium	good	bedrock knoll & floodplain	good	low lying edge floodplane	rock knoll	300	300	na	na	na	unknown	1,800
Huni (?)	Meydum	limestone, marl	very poor	E1, E2: levelled bedrock	poor	soft low rising slope	even desert surface	150	300	1,000	S; poss N from Saqqara	1,000	unknown	<6,200

Table 9.4. Locational setting of royal mortuary complexes from Snefru to Shepseskaf (II)

King	*Site*	*Geology*	*Ground Quality*	*Foundation Type*	*Final Foundation Quality*	*Slope Type from Valley*	*Relief*	*Distance to Escarpment (m)*	*Distance to Wadi Entrance (m)*	*Dist. to Local Quarry (m)*	*Quarry Location*	*Dist. to Fine limestone Quarry (m)*	*Dist. to Lake or Canal (m)*	*Dist. to River (m)*
Snefru	Meydum	limestone, marl	very poor	E3: sand	poor	soft low rising slope	even desert surface	150	300	1000	S	55000	unknown	<6200
	Dahshur	slatey clay, desert gravel	very poor	unstable slatey clay	poor	medium rising slope	even desert surface	1,600	1,800	1,000-1,700	E	15,000	1,800	6,000
	Dahshur	slatey, clay desert gravel	very poor	artificial: Turah limestone foundation	good	medium rising slope	even desert surface	2,000	2,000	1,800-2,000	SW; W	14,000	2,400	7,000
Khufu	Giza	thick limestone rock knoll	very good	bedrock knoll & levelling	good	steep high cliff	rock knoll	410	530	500	S	24,700	500	790
Djedefre	Abu Rawash	chalky limestone	very good	bedrock knoll & levelling	good	very high steep cliff; soft rising wadi	rock knoll	100	2,000	1,800	NE	32,800	unknown	2,000
Khafre	Giza	thick limestone sequence	very good	bedrock surface & levelling	good	medium rising slope	rock knoll	680	800	530	E	24,700	450	1,125
Nebka (?)	Zawyet el-Aryan	marly limestone	good	bedrock surface levelled	good	medium rising cliff	uneven desert surface	125	500	unknown	unknown	21,000	unknown	1,200
Menkaure	Giza	thick limestone sequence	very good	bedrock surface	good	soft low rising slope	uneven desert surface	420	1,000	300	SE	24,700	675	1,575
Shepseskaf	South Saqqara	marly limestone	moderate to poor	artificial: Turah limestone foundation	good	medium rising slope	even desert surface	800	1,100	3,000	SW	12,700	unknown	1,860

From Mudbrick to Stone

Khasekhemwy was the largest consumer of mudbricks for the ED. The level of organisation required for the construction, aggrandisement and modification of his monuments was substantial. He consumed around 55,000 m^3 of mudbrick compared to the 1,320 m^3 Bestock (2008: 33) estimated for Qa'a's tomb. His building work was uniquely distributed over two sites in the south of Egypt, 150 km apart, and spread over three major monuments: his tomb and associated enclosure at Abydos, where there was a tradition of large-scale mudbrick building; at Hierakonpolis, the first such structure built outside of Abydos; and it is also possible that he was responsible for a limestone enclosure, the Gisr el-Mudir, at Saqqara (see section 6.4).

Evidence presented in Chapter 6 indicates that, for his mudbrick structures, Khasekhemwy was able to consume large volumes of quality materials, such as fertile alluvium and chaff, both of which may have been at a premium, especially at Hierakonpolis where the flood plain is narrower than at Abydos. He also had access to a well organised, expert managerial team that oversaw (a) the acquisition of these multi-sourced ingredients in large quantities, (b) the manufacture of large volumes of systematic, homogeneous, quality mudbricks, potentially during a narrow window of time and (c) expert masons that built in a single effort the largest mudbrick enclosure to date at Abydos. A high degree of expertise is visible at all levels of production. Given how embedded the royal funerary structures were in the local ritual landscape at Abydos, the expert production may be a local tradition attached to the Abydos settlement (Derchain 1990: 219-42).

The main consideration to bear in mind when assessing the logistics of mudbrick construction is that before the material can be used in the monument, different ingredients must be brought together, mixed and cured. The ingredients for mudbricks, the main material for domestic architecture, tended to be widely available. Yet, it is significant that the evidence presented in Chapter 6, and Appendix C, show that there was variable access to materials and different degrees of expertise for mudbrick production of different structures across time, but especially in Khasekhemwy's reign. This would be expected in a society in which mudbrick was a dominant yet still relatively 'young' material (mudbrick was first introduced c.200-300 years earlier; Kemp 2000). The curing process is largely a seasonal activity. Optimal curing in Egypt takes place in autumn and spring, which may be an important seasonal restriction on the production of the large volumes of quality bricks that royal projects such as Khasekhemwy's required, especially because of the type of high smectite alluvial clays used in the Nile Valley, which reacted to temperature and moisture variations.

All the bricks tested from Khasekhemwy's enclosures at Abydos and Hierakonpolis, and the comparative samples from earlier and later monuments at Hierakonpolis (see Appendix C), exhibit a distinctive recipe, confirming how local in character mudbrick production can often be (as studies of mudbrick production highlight; Kemp 2000). Recipes also point to different access to material and expertise. All the bricks tested also show that, regardless of brick quality, there was a general awareness of the Egyptian alluvial clay's tendency to expand and shrink and efforts were made to counter such an adverse effect. Yet, my study shows that these local recipes were in part determined by what was environmentally available (such as the valley's topography or geomorphology and the season of production) but also determined by the kind of production involved, and expertise, which may be connected to monument type and owner's standing. Bricks produced by a tax-brick system, which meant drawing upon different local brickyards, possibly tended by local families, show a wide range of recipes and ingredients, as well as variable degrees of specialisation. Use of local brickyards better suits the evidence from the Abydos cult building and the Hierakonpolis enclosure phase 1 bricks. More centralised production will yield more homogenous bricks and access to quality resources will be more obvious, as with the Abydos enclosure and the Hierakonpolis enclosure phase 2 bricks.

It is significant that the majority of Khasekhemwy's structures show distinct building stages. Except for Khasekhemwy's enclosure at Abydos and that of his immediate predecessor Peribsen, building stages are a common feature of ED royal tomb substructures at Abydos (Dreyer *et al.* 1992), and have also been noted in the 2nd dynasty RMC substructures (Lacher 2011) and Djoser's RMC at Saqqara (Lauer 1936a,b, 1988). While most seem to indicate different building stages during the reign of one king, others seem to point to monument reuse. It remains unclear how much time elapsed between phases in Khasekhemwy's monuments, but the stages do show that building was clearly broken down into a series of smaller projects which may correspond to different seasons of construction, potentially driven by the inherent seasonality of mudbrick production and workforce availability, as commonly noted with earthen production (Ikram 2004: 161; Van Beek 2008: 149). Khasekhemwy's tomb at

Abydos is the largest, deepest tomb and the furthest ED royal tomb from the cultivation, the main source of materials, and shows the most building phases of all known ED RMCs. Although it was not possible to sample the bricks for the purposes of this research, different masonry types were noted, suggesting that some time elapsed between building phases; yet, the general idea seems to be that all phases correspond to Khasekhemwy's reign (Spencer 1979a: 14; Dreyer *et al.* 2003). The mudbricks of his tomb that look very dark and appear to contain little to no chaff compared to those of his enclosure at Abydos point to a different recipe than that of his enclosures. In contrast, Khasekhemwy's enclosure at Abydos was built in a single phase, with masonry that shows great skill, as the mudbricks' homogeneous, silty and high chaff content recipe indicate. Given the detailed evidence of Chapter 6, it is likely that specialists carried out each stage of manufacture and construction, with a clear management structure controlling and overseeing the whole production. Khasekhemwy's Abydos enclosure recipe called for large volumes of quality ingredients such as good Nile silt that was traditionally essential for growing crops and the heavy use of chaff essential for feeding animals, and this may have been a further sign of conspicuous consumption. Although it cannot be proven at this stage that all the materials were sourced locally (e.g. within 5 km or so), the difference in production compared to Hierakonpolis suggests that the width of the valley at Abydos could have been a factor in the provision of the main ingredients in such volumes. Khasekhemwy's enclosure, which was designed to be monumental from the outset and never dismantled, bears a clear stamp of quality.

Although further research would be necessary to confirm this, the impression that the mudbricks used for Khasekhemwy's enclosure are similar to Peribsen's points to strong continuity in practice and/or reuse. Ethnographic evidence demonstrates that old bricks are one of the best sources of material to make new bricks (Van Beek 2008); using old bricks is also time-efficient (by providing a ready mix as old bricks can be easily broken down by crushing and adding water). This is particularly true if the source of the old bricks is close to the new construction site, as would have been the case with Peribsen and Khasekhemwy. It remains unknown where the old bricks found in the basin inside the precinct of Khasekhemwy's enclosure came from and what the new bricks were used for. The proximity of the earlier enclosures and the fact that these structures were brought down at the end of each reign (see section 9.3) may indicate that each structure provided much of the material used by the succeeding king. The reasons for leaving the brickyard inside the enclosure's precinct while the chapel was in use are unclear, but remain especially intriguing given the likely sanctity of the enclosure space (Friedman 2007; Adams and O'Connor 2008; McNamara 2008).

In contrast to Khasekhemwy's enclosure and perimeter wall at Abydos, the fact that three different types of bricks – which altogether are close to the Hierakonpolis 1st phase bricks in sandiness and heterogeneity (see Chapter 6) – were used for Khasekhemwy's cult building at Abydos shows a completely different approach to the enclosure and perimeter wall bricks. The two relatively good and one very poor recipe indicate different sources of material and degrees of expertise. If the chapel belongs to Khasekhemwy, it shows that either (a) two very different manufacturing systems and building methods coexisted, with the cult building entailing simpler construction that called upon different local brickyards or brick-making households, something akin to the tax-brick system, or (b) that the enclosure and the cult building were built in different phases within the same reign. In light of the cult building's misalignment with the rest of the enclosure, the different recipes and heterogeneity are suggestive of a different and most likely earlier construction phase for the cult building. The less control and expertise exhibited in the mudbrick production and construction of the cult building suggest that the specialists called upon for the enclosure were absent for the cult building. While it might be that a non-specialist local workforce was left in charge of the cult building after the specialists had left (possibly to oversee the building of the second phase at Hierakonpolis) it seems more likely that Khasekhemwy incorporated an earlier structure and that the enclosure could not be aligned to the cult building due to the enclosure's planned dimension and the available space. Regardless, it is significant that the cult building's construction strategy differs from that of the enclosure, and suits a less skilful and less controlled mode of manufacture. If the chapel belonged to a predecessor and was reused by Khasekhemwy, the differences noted may shed light on changing mudbrick building logistics and priorities at the royal cemetery at Abydos. The fact that the chapel required little of the total volume of bricks produced for the Abydos enclosure features indicates that it could have been very easy to build the enclosure elsewhere and construct a new chapel inside it that was better aligned with the rest of the structure, as was the case with all 1st dynasty enclosures at Abydos. Note that a similar pattern of misalignment is also visible at Peribsen's enclosure (fig. 2.13). So why were the two structures not aligned? If the chapel is earlier, the evidence points to the existence of certain ideological reasons prompting the incorporation of an earlier chapel, or structure possibly from a predecessor's reign.

Contrary to the Abydos enclosure, Khasekhemwy's Hierakonpolis enclosure was built in two distinct phases, each with its own recipe. The make-up of the first phase bricks – which are heterogeneous, sandy, have much midden-waste content, use very little chaff and show significant mixing of different sediments – suggests that fresh silt may have been at a premium. The bricks point to a 'poor man's' enclosure, exhibiting restricted access to materials and less expertise in production and construction. One possibility is that they reused bricks, as the enclosure was built on an old Predynastic cemetery and near a Predynastic settlement. This would explain some of the Predynastic pottery micro-fragments found in the bricks and poor mixing would result in layers created by dissolving bricks. Still, the bricks show a very efficient, cheap means of manufacture. In contrast, the second-phase bricks at Hierakonpolis are akin to those from the Abydos main enclosure recipe. The architectural modifications carried out on the Hierakonpolis enclosure made it similar to the Abydos one, suggesting a convergence of strategies. Though the bricks retain a local signature, they also clearly bear the stamp of an Abydos-like production with a composition that is much cleaner, siltier and containing more chaff, as at Abydos, than the first phase bricks, indicating that the brick makers had access to higher quality materials and expertise.

Overall, it is significant that Khasekhemwy was able to consume large volumes of mudbrick, with materials reflecting a high degree of expertise and control; he or those working under him also oversaw the logistical demands of building three monumental mudbrick structures (one tomb and two enclosures) at two sites 150 km apart. The different composition of the mudbricks and the different masonry techniques used at Abydos and Hierakonpolis point to different qualities of structures and organisations of labour that may be tied to the type of building and/or distinct building phases and location in Egypt. The distinct manufacturing strategies at Abydos may have been more centralised, with a more specialised strategy applied to construction of the enclosure and perimeter wall than to the Abydos cult building. There was a less controlled, tax-brick strategy for the Abydos cult building, in which sourcing of materials and production was down to the co-option of different, less specialised individual producers who were possibly in charge of all aspects of production. This differs from specialised producers. The two structures were built at different times, perhaps even several reigns apart. The first phase at Hierakonpolis shows a production that is akin to the Abydos cult building, though not as variable, with more restricted access to materials compared to the 2nd phase and the Abydos enclosure and perimeter wall, with potential reuse which could explain the type of variability and layering. The second phase combines a local production type with a more sophisticated Abydos one. While this cannot be proven, the evidence does suggest a possibility of Abydos expertise, or Abydos-like expertise being exported to Hierakonpolis for the second building phase.

It is also particularly significant that Khasekhemwy employed a stone workforce at Abydos, Hierakonpolis and probably Saqqara. At Abydos, Khasekhemwy had access to limestone specialists for his tomb, for which limestone blocks were roughly shaped on the exposed faces for his burial chamber, the blocks of which were very well joined, and probably for his tomb superstructure casing. Although the provenance of the stone is unknown, incisions on the blocks show that organised quarrying already existed (Dreyer *et al.* 1992). Khasekhemwy's use of Aswan granite at Hierakonpolis, from 120 km south of Hierakonpolis, for finer architectural details (column bases, lintels) is more elaborate than that in Den's tomb at Abydos; Khasekhemwy's features were fully shaped on all sides and some were incised, something which requires specialist craftsmanship. At Abydos and Hierakonpolis Khasekhemwy was able to employ stone specialists in addition to sophisticated monumental scale mudbrick production.

If Khasekhemwy also oversaw the building of the monumental limestone enclosure at Saqqara, known as the Gisr el-Mudir (as is generally accepted; Tavares 1995; Mathieson 2000; Van Wetering 2004), then he may be the first king to oversee large-scale consumption of stone for monumental masonry. Despite a relatively poor execution compared to later stone structures, a reassessment of the patterns visible in the construction methods, overall execution and use of materials (see section 6.4) shows that the Gisr el-Mudir does exhibit some degree of skill in stone masonry, rock-cutting and basic earthen architecture techniques (extending the harder, masonry foundation mortar to form a levelling buttress or strengthening corners). This points to different groups with different expertise working within certain temporal constraints for Khasekhemwy's projects. Yet, the specialist quality of building at Saqqara was limited to the north wall: the execution of this part is excellent given it may be the first major stone masonry in Egypt and was carried out with fine limestone blocks throughout, potentially attaching skill to the finer material (see section 6.4). Aside from the north wall, the rest of the structure shows a lack of masonry skills; the lack of corner bonding and the fact that the masonry ranges in quality from north to south indicates that (a) the builders did not start with the corners and (b) the walls were probably not raised together, but individually, contrary to what would be expected for structural integrity. This and the recurrence of straight vertical joins and the heavy reliance on earthen architecture techniques (extending the harder, masonry foundation mortar to form a levelling buttress or strengthening corners with stone) to make up for the poor masonry are all things that most Egyptians would probably recognise from the maintenance of their own houses. Overall, it may point to a small workforce of specialists for the north wall, and non-specialists for the rest.

The rest of the tasks required (such as the scraping of the desert surface, cutting of foundation trenches and the east plinth, and the minimally-dressed blocks easily acquired by breaking naturally occurring sheets of limestone) all point to local, rock-cutting manufacture easily provided by the workforce responsible for the extensive 2nd dynasty rock-cut galleries due east at Saqqara and transferred here to a stone masonry project. Mason marks painted on blocks *in situ* and the cuts from the Abydos blocks (see also section 6.1) are the earliest evidence of organisation surrounding stone quarrying and construction. Although this is at the limit of what the evidence enables us to say, it may be significant that the inscriptions are executed in different media, which points to different groups and sources of material; it is possible that the Abydos blocks come from a local source. While the marks painted on blocks of Gisr el-Mudir *in situ* may be more about placement of the blocks, the Abydos incisions may be quarry marks tied to the organisation of the workforce and the transportation of the blocks from quarry to building site.

In conclusion, the spatial-logistical scope of the Gisr el-Mudir is not dissimilar to mudbrick architecture but here unfolds within a local, rock-cutting framework. The above points suggest that the bulk of the structure was erected by a workforce that primarily had rock-cutting (rather than wider stone masonry) skills, with perhaps a large number of unskilled helpers and a small group of stone specialists at certain times. The evidence also points to the need to build big and fast, which in many ways is also felt with the Hierakonpolis enclosure's second phase (Friedman 2008), both in terms of building strategy and mudbrick composition.

The fact that Khasekhemwy and his immediate predecessor Peribsen built their RMCs at Abydos in mudbrick is often seen as a step back from the more demanding logistics of the larger 2nd dynasty rock-cut galleries at Saqqara to an older and simpler building paradigm that is characteristic of the earliest RMCs at Abydos. However, these structures, especially Khasekhemwy's, have never been considered in any detail and the analysis in Chapter 6 shows that there was much more to mudbrick building than traditionally thought, with Khasekhemwy's mudbrick projects calling for varying access to resources, skill and expertise.

In light of the above, the logistics of Djoser's RMC are not so different from the building activities of Khasekhemwy at Abydos. Djoser's is a local project, built in an established royal cemetery site, employing largely locally available materials with a few finer off-site sources, moving toward an ever greater scale than that of his immediate predecessor, comprising several building stages and design modifications. The main differences with Khasekhemwy's building activities is that Djoser's activities are focused on a single site; his architecture is essentially entirely stone-built and as such was much larger than Khasekhemwy's tomb and enclosure constructions at Abydos; Djoser also employed more skilled stone masons.

Djoser's RMC, which is generally considered the first stone RMC that required large-scale organised quarrying, is an improvement on the large-scale rock-cutting (versus the more involved stone shaping required for quality masonry) already evident in the 2nd dynasty galleries, Hotepsekhemwy's terracing and the Gisr el-Mudir. As already noted above, cut marks on the limestone blocks from Khasekhemwy's tomb at Abydos and the red marks painted on the blocks of the Gisr el-Mudir indicate that organised quarrying and some degree of organisation for large-scale stone building activities was already in place prior to Djoser's reign. The size and treatment of the masonry blocks of each construction stage of Djoser's pyramid show a clear progression in technique (Lauer 1936a; 1985): blocks become larger and better dressed and are cemented with less mortar, becoming small versions of the blocks quarried for later RMCs, rather than being largely influenced by the logic of mudbrick masonry. For the first time, dressed blocks of limestone are used for the masonry of a royal superstructure. From Djoser onwards, blocks systematically increase in dimension. Djoser's blocks at Saqqara were obtained by breaking sheets of naturally occurring limestone on the plateau, using basic rock-cutting expertise. This was a relatively easy process compared to later quarrying carried out for the Giza RMCs, where hundreds of multi-ton blocks were individually cut on all sides and removed from a mass of limestone. Djoser employed specialist stone sculptors to carve out and shape the fine limestone structures in his complex, including the monumental enclosure that surrounded his RMC, the niches of which were entirely carved out of the masonry *in situ* rather than formed using bonded masonry, whereas the palace-façade motif was obtained through bonding. This shows a very different approach that is more aligned with sculpting, and contrasts with the approach taken in contemporary and earlier monumental mudbrick architecture.

Djoser

Finally, Djoser's reuse of older structures and materials was logistically advantageous and may have been instrumental in directing his efforts towards what may be described as more aesthetic activities, such as fine sculpting of dummy temples, the polishing of the granite with copper tools or the shaping and proper dressing of limestone blocks. The fact that Djoser reused many stone vessels from predecessors certainly links earlier monuments to the aesthetic labour involved in such activities. The fact that such a large proportion of the inscribed stone vessels were not his (Firth and Quibell 1935: ii, 41; Aston 1994) may indicate that this aesthetic labour was, partially at least, transferred to his monument, as has been suggested for later in the OK (Bevan 2007: 70-1). Reuse also has a symbolic dimension that will be discussed in section 9.3. Given the local tradition of stone architecture – the first use of which is attested across the valley at Helwan, then at Saqqara with some of the 1st dynasty private tombs and then 2nd dynasty evidence (La Loggia 2008, 2009) – and possible large stone vessel production attached to the capital (Bloxam *et al.* 2009), Djoser likely used a local workforce, merging stone-cutters with stone-sculptors within a managerial infrastructure most likely set up by his immediate predecessor Khasekhemwy.

Sekhemkhet

It is difficult to assess fully the logistical scope of Sekhemkhet's RMC, as it was left unfinished, but it appears to have been designed to be a larger version of Djoser's RMC. However, two major differences are (a) there is no reuse of the structure or constituent materials, and (b) his tomb and enclosure were designed at a greater scale than Djoser's. This indicates that altogether perhaps the overall volume of material required would have ultimately been greater. Also, the fact that the tomb substructure was cut in a topographically uneven area with slightly poorer quality bedrock than Djoser's RMC, requiring the building of a foundation platform and the strengthening of the substructure's gallery walls, may have ultimately made the project more costly if the same material orchestration was planned.

Khasekhemwy, Djoser and Sekhemkhet's RMCs were essentially local projects that unfolded at a monumental scale in familiar locations with local materials. Khasekhemwy and Djoser's projects are quite similar in that they both built at a significantly larger scale than their predecessors, but did so in familiar royal setting, drawing upon local enterprises for bulk materials and introducing finer materials for their burial chambers, and, in the case of Khasekhemwy's second enclosure at Hierakonpolis, for a number of finer architectural details such as column bases and lintels. Both building programs show some degree of reuse and have multiple building stages, with Djoser's being an up-scaling and centralising (in one place at the political capital) version of Khasekhemwy's, in a way perfecting Khasekhemwy's logistical scope. Sekhemkhet then sought to continue this tradition at a slightly increased scale. As we shall see, to these three may be added Khaba's, who, apart from a significant change in location, the logistical implications of which are discussed below, the material design of which is a continuation of Djoser and Sekhemkhet.

Decentralising Royal Building Projects

After Hotepsekhemwy's move of the royal necropolis from Abydos to Saqqara at the start of the 2nd dynasty, Khaba is the second king to inaugurate a new royal cemetery. However, the major difference with Hotepsekhemwy is that the move was regional, just 9 km north from Saqqara, at Zawyet el-Aryan, and that the new site had the advantage of presenting similar affordances to Saqqara. While being only 10 km downstream from the previous project, hence enjoying similar infrastructural benefits by virtue of its proximity to the capital, the overall locational parameters, layout, shape and materials used for Khaba's RMC can be understood as the perfecting of a monumental template laid down by his predecessors Djoser and Sekhemkhet at Saqqara. The reduced size of the complex, visible in the smaller superstructure and a substructure that was initially planned to be closer to the surface, could be a response to his predecessor Sekhemkhet's plans being deemed over-ambitious, but also a factor of distance from the capital and its logistical affordances. Khaba's substructure was eventually modified four times, each time making it deeper and more extensive, which is reminiscent of the 2nd dynasty substructures at Saqqara and Khasekhemwy's at Abydos, and may be seen as a reverse process to Djoser's superstructure and its own multiple aggrandisement stages above ground. The RMC building project thereby became a platform where both local and wider provincial workforces and bureaucracies could merge, potentially contributing to the consolidation of central authority.

As discussed in Chapter 2, the material and textual evidence for the period after Khaba and up to Snefru is incomplete to the extent that we are unsure how many kings ruled, who they were or how many known buildings can be attributed to this time span (see section 2.4). The following section attempts to reconstruct developments in the logistical requirements associated with two known structures here considered to be attributable to this period: the mudbrick RMC at Abu Rawash and the first phase E0 of the Meydum pyramid. We have very little information about the mudbrick complex built at Abu Rawash, but the pottery evidence and layout of the internal apartments support a late 3rd dynasty date (see section 7.4). If we assume that the RMC was built soon after Khaba's, e.g. by his successor, then it involved yet another move downstream further into the Delta. Unlike the previous stone RMCs built in the desert, it was perhaps logistically more advantageously built at the floodplain level, at the edge of the cultivation with mudbricks laid around a rock knoll core (a practice that would later become standard for all the RMCs built between Abu Rawash and Giza) to make up for the continued shift further from the capital. If the first often ignored building stage known as E0 at Meydum was potentially an independent RMC of the late 3rd dynasty (see sections 2.4 and 7.5) then the similarities between Abu Rawash and Meydum E0, such as the reduced logistical scope associated with the building of the structures and almost identical layout of the internal apartments, suggest that they were built close in date, perhaps in sequence. The reduced logistical scope and similar internal layout, which was a drastic move away from all previous RMCs, and their respective placement marking the northern- and southernmost limits of the stretch of the royal pyramid field – the northernmost with mudbrick and the southernmost with stone – strongly suggest that, whether deliberately or not, the two structures might work in tandem. If E0 was built after Abu Rawash, then E0 at Meydum represented a radical locational shift, moving the royal project infrastructure 75 km south and upstream.

It is also interesting to look at Abu Rawash and Meydum E0 in connection to another set of royal building projects belonging to the end of the 3rd dynasty and generally attributed to Huni, a group of MSPs (Minor Step Pyramids) constructed across Egypt, of which seven remain (fig. 7.31; Lauer 1962a; Dreyer, and Kaiser 1980; Cwiek 1998). The presence, date, placement and material use of the MSPs may lend more weight to a connection between the two Abu Rawash mudbrick and Meydum E0 structures. All MSPs share similar locational characteristics; they are parallel to the river, on elevated points at the end of trade routes near to important centres either side of the Nile Valley (Cwiek 1998) and built with local materials. The MSP on the island of Elephantine at Aswan was built with local granite, those along the Nile Valley with limestone, and two in the Delta with mudbrick (including the Ed Deir in addition to the Athribis one; for Athribis MSP see Rowe 1938). These structures were not tombs. Their shape, presence of chapel-like features and strategic placement that emphasises connection/visibility from the Nile (elevation and parallel placement to the river) and in the local landscape, as well as proximity to key economic centres or provincial markets, suggests that they may have marked redistribution centres and/or places associated with the royal cult (Lauer 1962a; Dreyer, and Kaiser 1980; Cwiek 1998) or at least that royalty wished to associate itself with these key provincial centres. Of significance to this stage of the discussion is the fact that several royal building projects were overseen across Egypt towards the end of the 3rd dynasty that emphasised, through their placement, a desire to move the royal building projects away from the political centre out towards the provinces using what was locally available. In this light the MSPs highlight a similar logistical scope visible in the mudbrick RMC at Abu Rawash (the furthest north built with mudbrick, and possibly the small stepped E0 pyramid at Meydum) the furthest south of the capital and built with stone. Regardless of the exact timing or number of kings that ruled at the end of the 3rd dynasty, the overall approach to the known monuments is significant especially in light of what follows with Snefru and his successors' building programs that expand logistically this process of centres and provinces via the use of off-site materials.

Table 9.5. Material orchestration in royal mortuary complexes from Khasekhemwy to Shepseskaf (I)

King	*Site*	*Completion*	*Sarcophagus*	*Burial Chamber Floor*	*Burial Chamber Walls*	*Burial Chamber Ceiling*	*Burial Passage*	*Entrance Corridor*
Khasekhemwy	Abydos	finished	wood ?	limestone	limestone	limestone	na	mud plaster, whitewash
	Abydos	finished	na	na	na	na	na	Fine limestone steps
	Hierakonpolis	finished	na	na	na	na	na	bedrock
	Saqqara	unfinished	na	na	na	na	na	bedrock
Djoser	Saqqara	finished	granite	travertine anorthosite gneiss; granite	travertine; granite	limestone blocks with carved stars; granite	bedrock	bedrock
Sekhemkhet	Saqqara	unfinished	travertine	bedrock	bedrock	bedrock	bedrock	limestone masonry, bedrock
Khaba	Zawyet el-Aryan	unfinished	sarcophagus	bedrock	bedrock	bedrock	bedrock	bedrock
Unknown	Abu Rawash	unfinished	unknown	bedrock	bedrock	bedrock	bedrock	bedrock, mudbrick
Unknown/Huni?	Meydum	finished	unknown	bedrock	bedrock	fine limestone ?	unknown	unknown
Snefru Meydum	Meydum	finished	wood ?	fine limestone ?	fine limestone ?	fine limestone ?	fine limestone	limestone masonry
Snefru Bent	Dahshur	finished	unknown	limestone	limestone	limestone	limestone	limestone masonry
Snefru North	Dahshur	finished	unknown	limestone	limestone	limestone	limestone	fine limestone
Khufu	Giza	finished	granite	granite	granite	9 granite beams & 5 relieving chambers	granite	fine limestone, bedrock
Djedefre	Abu Rawash	finished	granite	granite	granite	granite	granite	limestone, bedrock
Khafre	Giza	finished	granodiorite	bedrock	bedrock	limestone 17 x 2 beams	fine limestone	granite
Nebka	Zawyet el-Aryan	unfinished	granite	granite	granite & fine limestone	na	granite (?)	fine limestone
Menkaure	Giza	finished	granodiorite?	granite	granite	granite	granite	granite
Shepseskaf	SouthSaqqara	finished	greywacke	granite	granite	granite 7 beams	granite	fine limestone

Table 9.6. Material orchestration in royal mortuary complexes from Khasekhemwy to Shepseskaf (II)

King	*Site*	*Superstructure Masonry*	*Completion*	*Superstructure Casing*	*Foundation*	*South Tomb*	*Mortuary Temple*
Khasekhemwy	Abydos	rubble	finished	mudbrick, limestone	none	na	unknown
	Abydos	na	finished	na	compacted silts & sterile s&	na	na
	Hierakonpolis	na	finished	na	compacted silts & sterile s&	na	na
	Saqqara	na	unfinished	na	north & south wall rock-cut trench	na	na
Djoser	Saqqara	local limestone & heavy mortar	finished	fine Sq limestone	1 course limestone	same as tomb	limestone, fine Saqqara limestone & mudbrick floors
Sekhemkhet	Saqqara	local limestone & heavy mortar	unfinished	fine Sq limestone	local limestone masonry foundation platform	limestone	limestone
Khaba	Zawyet el-Aryan	local limestone	unfinished	local limestone?	bedrock	na	na
Unknown	Abu Rawash	artificially exposed rock knoll, mudbrick	unfinished	unknown	bedrock?	na	na
Unknown/Huni?	Meydum	local fine limestone	finished	local fine limestone	desert surface	limestone	na
Snefru Meydum	Meydum	E2 fine local limestone; E3 fine & soft limestone	finished	E2 fine local limestone; E3 soft local limestone	limestone blocks	limestone	limestone, fine limestone walls & mudbrick with mud plaster floors
Snefru Bent	Dahshur	local limestone	finished	Tura limestone laid in 3rd dyn technique	desert surface	limestone & travertine altar	mudbrick walls, travertine offering table, limestone wall lining, granite stela
Snefru North	Dahshur	local limestone	finished	Tura limestone decrease in size with height	limestone blocks	"scattered limestone chips"	mudbrick, limestone for front only, granite false door
Khufu	Giza	rock knoll, local limestone, s&, rubble	finished	Tura limestone	bedrock	limestone	limestone walls, basalt floor, granite columns, fine limestone
Djedefre	Abu Rawash	rock knoll, local limestone	finished	minimum of 20 courses granite	bedrock & c. 450 sq m Tura limestone below casing	chalky limestone outcrop	mudbrick walls, granite columns
Khafre	GZ	rock knoll, local limestone	finished	2 course granite & Tura limestone	bedrock	limestone	granite wall lining & columns, 2 chambers travertine wall lining, travertine floor paving
Nebka	Zawyet el-Aryan	local limestone	unfinished	Tura limestone	bedrock in part levelled	na	na
Menkaure	Giza	rock knoll, local limestone	finished	16 courses granite & Tura limestone	bedrock & limestone blocks	na	limestone, granite, granodiorite all covered with mudbrick finish
Shepseskaf	SouthSaqqara	local limestone	finished	1 course granite & tura limestone	fine limestone	na	limestone, mudbrick

Table 9.7. Material orchestration in royal mortuary complexes from Khasekhemwy to Shepseskaf (III)

King	*Site*	*Causeway*	*Valley Temple*	*Enclosure*	*Portcullises or Plugs*
Khasekhemwy	Abydos	wadi floor	mudbrick, mud plaster, whitewash	mudbrick, mud plaster, whitewash	unknown
	Abydos	na	na	na	na
	Hierakonpolis	na	na	na	na
	Saqqara	na	na	na	na
Djoser	Saqqara	wadi floor	na	limestone & fine limestone	granite
Sekhemkhet	Saqqara	wadi floor	na	limestone & fine limestone	unknown
Khaba	Zaeyet el-Aryan	na	na	na	na
Unknown	Abu Rawash	na	na	na	na
Unknown/Huni?	Meydum	limestone, mudbrick	mudbrick?	mudbrick?	na
Snefru Meydum	Meydum	mudbrick, mud plaster, limestone floors & walls	mudbrick	limestone	wood possibly
Snefru Bent	Dahshur	mud floor, limestone foundation & fine limestone walls	limestone	limestone with fine limestone upper courses	limestone
Snefru North	Dahshur	rock-cut & limestone masonry	unknown	trace fine limestone	unknown
Khufu	Giza	limestone masonry	basalt paving, limestone, mudbrick, granite	limestone	granite
Djedefre	Abu Rawash	rock-cut & rough limestone masonry	unknown	mudbrick	granite
Khafre	GZ	granite lining	granite wall lining & columns, basalt door lintel, travertine paving & channels	limestone	2 granite
Nebka	Zawyet el-Aryan	na	na	limestone	na
Menkaure	Giza	limestone foundation & mudbrick walls and floor	mudbrick with limestone blocks foundation, few blocks for walls	mudbrick	limestone & 3 granite
Shepseskaf	S. Saqqara	mudbrick	unknown	mudbrick	3 granite plugs

The Introduction of Non-Local Materials in Bulk

Snefru oversaw the building of several projects. With his two RMCs at Dahshur and aggrandisements of the Meydum RMC and the Seila MSP 10 km west of Meydum, he introduced a much larger scale of royal building activities than previous ones. Snefru was not only the largest consumer of limestone for royal monuments of any early Egyptian ruler (fig. 8.33; Stadelmann 1980), he was also responsible for the dramatic expansion of the geographic breadth of construction of RMCs. Snefru built over a 45 km stretch that covers more than half of the pyramid field around the capital and defines its southern stretch south of the capital. Snefru also initiated the large-scale acquisition of fine limestone from an off-site source (Maasara), thus changing the geographical scope of bulk material acquisition of royal building logistics from an emphasis on the sourcing of local materials to material resource extraction from a wider portion of Egypt. The 45 km section of the west bank chosen by Snefru for his monuments is south and upstream from the capital, has poor bedrock, and does not provide both soft and fine limestone in sufficient quantities (Klemm and Klemm 2010: 68; Arnold 2013). Still, Dahshur may have been selected, amongst a wider group of candidate sites, because it was closer to the Tura-Maasara quarries that offered the fine limestone needed, but still south of the capital, an area which Snefru seem to have favoured for his monuments. The Tura-Maasara quarries remained the main source of fine limestone for all subsequent RMCs, with each ruler thereafter opening a new gallery quarry along the Tura-Maasara stretch (Klemm and Klemm 2010: 60). This shift in the sourcing of fine limestone marks a major logistical development in the scope of royal building projects. For the first time, the geographical breadth of material consumption shifts from being highly localised around the building site to drawing from a wider region.

Although the evidence is not very clear, dates painted on building blocks from Snefru's main pyramids at Dahshur and Meydum suggest that building proceeded in phases and that the workforce was moved from one RMC project to another (Stadelmann 1993). At Meydum, Snefru may have benefited from having the workforce of his immediate predecessor on-site, which would have been logistically advantageous and also made it easy to dispatch a smaller contingent of workers to Seila for the slight modifications carried out on the MSP. Snefru then moved to Dahshur and the Bent, then the North pyramid, though it appears that he divided the workforce between Meydum, for its final casing, and the North pyramid (Stadelmann 1993). In this way, Snefru's building activities echo Khasekhemwy's emphasis on a series of different monuments.

Khufu's subsequent building project represents an even more impressive peak in the consumption of non-local materials than that of his father Snefru. Khufu leaves the region south of the capital to go to a logistically advantageous area north of the capital (15 km), at Giza. Logistically, Khufu's RMC may be seen as perfecting the design concepts laid down by his father by building the first pyramid considered 'perfect' (with a 52 ° and straight faces) and achieving one of the most complete RMCs ever built in Egypt. Giza was also advantageously situated downstream from all the main sources of off-site material brought to the site by a canal, strategically cutting down the logistical cost his father had faced with having to transport the limestone upstream from Maasara to Dahshur and Meydum; Giza was also closer to a prime agricultural region, the Delta, which may have been instrumental for provisioning such a large workforce. Economically, a large portion of Khufu's pyramid consisted of a rubble core laid around the knoll. This could have allowed human labour to be transferred to the quarrying and moving of the monumental blocks of local limestone required for the foundation and under-casing, the possible implications of which are returned to in section 9.2. In addition to Khufu's use of fine limestone from Tura-Maasara, he also, for the first time, used large volumes of two of the hardest stone types used in architecture, notably granite from Aswan and basalt from the Fayum. As with the limestone blocks, both granite and basalt units reached monumental proportions, but had the added complication of being very hard and each presenting unique working properties, such as break patterns and cutting or polishing requirements. Acquisition of both types of stone entailed seasonal restrictions, insofar as blocks of such dimension could only be transported during the inundation (Bloxam and Storemyr 2002; Kelany *et al.* 2009). In this light, Khufu's strategy echoes that of Djoser in three ways: (a) the variety of materials used (b) the expertise required (c) the practice of following a king (Snefru) who built at multiple sites (Khasekhemwy for Djoser).

After the scale and complexity of Khufu's RMC, Djedefre may have been prompted to select a highly visible site to make up for the less lavish material consumption and smaller pyramid size. Abu Rawash presented a number of logistical advantages. It is 8 km downstream from Giza, has high quality bedrock, offered the possibility to integrate a rock knoll into the structure – especially important for granite casing – and had readily available prime quality limestone from the excavation of the tomb substructure and a local quarry. However, the site's elevation complicated the logistics of construction by requiring the movement of off-site materials, such as granite, up a 1.5 km slope and the eventual transformation of the ramp into a monumental causeway. The reduced size of the pyramid, the method of construction of the sub- and super-structure, the quality of the local limestone, the roughly-shaped make-up of the limestone masonry walls, the use of mudbrick for the mortuary temple, the reduced use of Tura limestone (though this could be a factor of reuse) combined with the fact Djedefre reigned a minimum of 23 years, altogether implies that the intention with Djedefre's complex was to build a sturdy structure at reduced cost. Evidence from Djedefre's RMC reveals that granite craftsmen were responsible for the *entire* production sequence *on site.* Although the source cannot be established, it is also worth asking whether the granite came from Aswan or from his father's stores at Giza, which is much closer. In this light, the design of Djedefre's RMC points to a certain logistical co-dependence between the two projects, a linkage possibly echoed later with Khafre and Nebka's RMCs, as well as the RMCs of Menkaure and Shepseskaf.

Khafre returned to Giza and placed his RMC only a few hundred meters south of his father's in a location that required foundation work for his mortuary temple and causeway. It is interesting that while Snefru, Djedefre and Khafre's likely immediate successor Nebka returned to earlier 3rd dynasty RMC locations, Khafre did not. Perhaps other logistical advantages attached to Giza attracted him there instead. This is suggested by the fact that Khufu and Khafre's RMCs have the same location, but also share many similarities in layout, volume and types of materials used. Although Khafre did not consume basalt, he remains the largest consumer of granite and hence of hard stone overall. Khafre also employed for the first time large volumes of travertine. Hence, while his immediate predecessor Djedefre seems to have compromised on material type and scale in favour of a more remote and elevated location, Khafre favoured a location that offered optimal affordances and suited a lavish design that closely resembled that of his father, Khufu's.

Although it is difficult to determine the exact logistical scope of Nebka's project at Zawyet el-Aryan, it may be significant that the RMC shares a number of similarities with Djedefre's at Abu Rawash. Although Nebka moved upstream from Giza, Nebka's RMC shares many similarities with Djedefre's. Like Djedefre, Nebka moved his royal building project a relatively short distance from Giza, maybe because the site was upstream, and also returned to a 3rd dynasty royal cemetery, choosing a site with good quality bedrock and following an architectural design that is almost identical to

Djedefre's. Again it is worth asking if granite at least was brought up from Giza rather than Aswan, given the amount consumed by his predecessor Khafre at Giza.

Menkaure returned to Giza to build an RMC with a similar layout to Khufu and Khafre's. After Khafre, Menkaure's RMC represents the second largest consumption of granite and, had his RMC been completed, would have surpassed Khafre's effort in that regard. Some of the largest blocks of limestone ever used were found in his RMC, indicating a distinctive Giza-style of limestone masonry. His pyramid is comparable in size to Djedefre's at Abu Rawash and, like Djedefre, the RMC was completed in mudbrick. However, while Djedefre had a long reign and his RMC's rough finish seems possibly connected to his father's design, Menkaure's premature death led his successor Shepseskaf to oversee the completion of his RMC in mudbrick, splitting his workforce between two sites.

Shepseskaf left Giza and built his RMC 17 km south at South Saqqara, near the capital, chose a site with poor bedrock (soft and unstable), requiring the laying of artificial stone foundations. His complex's overall design had a far less demanding logistical scope than those of his predecessors. It employed far less material due to its reduced size and followed a much simpler design, with the monumental stone mastaba tomb superstructure being the smallest OK superstructure. As with all previous RMCs since Khufu, it employed local limestone, fine limestone and granite. A short reign and the fact that he oversaw the completion of Menkaure's RMC at Giza may explain the limited logistical scope. As mentioned in section 8.6, the use of granite ends suddenly in Menkaure's complex, after which it is replaced for a short period of time by Tura limestone, and then, more conspicuously, by mudbrick. The material evidence from both Menkaure and Shepseskaf's sites indicates that additional specialist granite workers were not available to Shepseskaf, as these had to be moved to take care of the earliest construction stages of his RMC that required granite masonry expertise, thus ending all granite work at Giza. Fine limestone craftsmen may have been available, but still limited. In all likelihood, a large number of the unskilled workforce was distributed between two sites while the smaller groups of specialists strategically were distributed across both, according to the building sequence. The evidence thereby clearly points to groups of specialists in limited numbers and attached to materials.

In conclusion, it is interesting to note that if the owner of the Zawyet al-Aryan RMC is indeed Khafre's successor (see section 2.4), a certain symmetry exists between the designs and logistical scopes of Khufu's and Djedefre projects and those of Khafre and Nebka; Khufu and Khafre's projects at Giza are large scale, lavish monuments of a certain design which contrast with those of their immediate successors nearby (8 km and 5 km respectively) at Abu Rawash and Zawyet el-Aryan. Although this is at the limit of what the evidence enables us to confirm, the locational and material patterns of these RMCs suggest that Djedefre's and Nebka's may be viewed as satellite projects with a more modest design very much limited by and potentially dependent on those of their immediate predecessors at Giza. Hence, as Memphis initially acted as a major resource pool for the Saqqara projects, Giza may thus have functioned as a similar, highly specialised resource pool, both human and natural, for the 4th dynasty RMCs at Giza. The spatial patterns of the material orchestration, both intra- and inter-site, of the 4th dynasty RMCs from Khufu onwards may point to an interesting relationship of 'co-dependence' with Giza. The fact that the only known workmen's settlement, which until now can only be dated to Khafre and Menkaure's reign (Lehner 2001, 2004), is at Giza and that no 4th dynasty RMC apart from Khufu and Khafre's was fully finished in stone could further support this notion of 'co-dependence'. In addition, the use of mudbrick of the later 4th dynasty RMCs may not always have had to do with a ruler's premature death, but with certain rulers having to absorb the cost of their immediate predecessor's lavish projects. A further assessment of the logistical scope of RMCs built from Khasekhemwy to Shepseskaf through a detailed consideration of monument placement and material use highlights a great deal of co-dependence between projects in a way that helps us go beyond looking at monuments as simple indexes of a single ruler.

9.2. RMC Building and State Consolidation

RMCs were not only a demonstration of the growing logistical capabilities of the state but they also acted as social platforms. This section of the chapter therefore explores the social impact that RMC building activities may have had on the different communities involved in RMC construction.

The Co-option and Enrichment of Local Communities at Key Centers

Each of Khasekhemwy's building projects appears to have involved local communities of workers and groups of specialist craftsmen at key centres of early kingship. They also show signs of increasing levels of expertise, bringing together larger numbers of people and/or introducing non-local practices, all of which may have been strategic for the later developments seen to characterise the OK's highly centralised state. For his enclosure at Abydos, Khasekhemwy called upon a group of local mudbrick specialists who seem to have been highly organised and to have worked in a prescriptive way. This type of specialisation and organisation contrasts with that called upon for the cult building inside his enclosure at Abydos and, to a lesser degree, for his other mudbrick enclosure at Hierakonpolis. If Khasekhemwy oversaw the building of the monumental enclosure at Saqqara, then he also employed local rock-cutters at the capital, which, given the size of the structure, would have brought together a much larger workforce. The evidence suggests that the mudbrick specialists were attached to Abydos and one possibility is that the artisans were attached to the local temple of Khentimentiu at Abydos, in a similar way that the groups of stone sculptors employed at later RMCs at Saqqara may have been co-opted from the temple of Ptah at Memphis.

Khasekhemwy also encouraged the transfer of expertise across sites and materials. The evidence suggests that some of the stone expertise from Saqqara was passed on to Abydos and some of the mudbrick expertise from Abydos to Hierakonpolis. It is worth asking whether Khasekhemwy was already moving smaller groups of specialists around Egypt, as was done later for the working of hard stones such as granite and basalt (Bloxam *et al.* 2009). Regardless, through his multi-site building program, Khasekhemwy was interacting with different communities of local specialists in ways that encouraged knowledge transfer. In line with this, the bringing together of mudbrick and limestone masonry in his tomb at Abydos may have inspired the use of roughly shaped blocks of limestone for a monumental stone enclosure at Saqqara and the subsequent developments seen with Djoser's RMC.

In the context of his probable reunification of Egypt after a period of socio-political turmoil, his ongoing projects in multiple locations that called upon different expertise groups may have been instrumental in bringing the wider population together. Although alternative interpretations are possible (see Chapter 6), one plausible scenario, under the assumption of a preceding period of political decentralisation, is that Khasekhemwy started with an enclosure in his home town, then moved to the ancestral burial ground of Egypt's founding kings for his RMC, where his immediate predecessor was also buried, breaking with the earlier tradition of the 2nd dynasty rulers at Saqqara. He then conquered the north, where he built the biggest enclosure and the earliest and largest free-standing stone structure attested at the time, here again with the local expertise. It is possible that he then returned to Abydos with the knowledge he had gained and modified his tomb according to the northern design, but working within the framework of local practice and expertise available to him at Abydos. Therefore, in this case the location, design and construction materials of Khasekhemwy's building program reflect the political situation and the discrete stages of the political process of reunifying Egypt and his life/maturation as a ruler.

In many ways, Djoser's social strategy may be seen as an upscaling of Khasekhemwy's priorities, but one that focuses all of the state's resources on a single site near the capital and on the consumption of a single material, stone. A clear temporal correlation exists between the emergence of large-scale stone-building technology at Saqqara in the 2nd and 3rd dynasty, the location of the cemetery in a demographically dense region near the capital and the Delta, unusual levels of material reuse in Djoser's case, and the consolidation of the state (La Loggia 2009). Djoser benefited from the large numbers of workers, specialists in stone-cutting and the managerial infrastructure attached to the capital and present locally. The Delta, the head of which would have been much closer to the capital than it is today, would easily provide most of the food required. Yet it is important to note that the strategy behind Djoser's RMC was already underway prior to his reign.

Djoser appears to enrich an existing local stone-cutting community with stone sculptors brought in to shape the harder limestone (specialists attached to material possibly already visible with the Gisr el-Mudir's north wall) and further specialists for the unprecedented consumption of granite in his burial chambers. The masonry of each building stage of Djoser's superstructure shows significant improvements, shifting from the 'rough and easy stone-cutting masonry tradition' to something far finer. It is noteworthy that Djoser's architect Imhotep, in addition to being 'Chancellor of the King of Egypt, Doctor, First in line after the King of Upper Egypt, Administrator of the Great Palace, Hereditary Nobleman, High Priest of Heliopolis,' was also 'Builder, Chief Carpenter, Chief Sculptor and Maker of Vases' (Hurry 2000). Imhotep may have been the one to bring in the stone specialist workforce, thus merging different communities of craftsmen with varying skills. Although we should not push the evidence too far, the reuse in Djoser's RMC of the majority of the inscribed stone vessels from earlier reigns suggests that the stone vessel workforce was transferred to architecture, in the same way that basalt stone vessel production drops in the 4th and 5th dynasties when it is integrated at large scales in royal funerary architecture (see Chapter 8; Aston *et al.* 1994; Bevan 2007: 72).

Moving Large Groups of Specialists

Khaba's move had important implications for all subsequent royal building activities. After a 400-year period in which royal building activities were tightly focused on nearby cultic and administrative centres at Abydos and Saqqara, all RMCs from Khaba onwards systematically change location. Although logistical and structural reasons appear to prompt Khaba's move (see section 9.1), something about it may have had unintended social consequences that were identified as positive and repeated. Although it is not clear to what extent local manual labour was called upon, the change in location almost certainly meant merging specialists from the capital with a more local workforce that the provincial elite provided. It may be that it is the socio-political scope of decentralising royal building projects that prompted this strategy. Overall, the pyramid age represented by large-scale RMCs was also a period of internal colonisation through the establishment of villages and estates across Egypt (O'Connor 1972: 681-98; Malek and Forman 1986: 35, 68-9). This part of the discussion examines how the choice of location and materials may have been instrumental in consolidating this process.

Changes in location appear to be a key concern for the RMC building activities between the reigns of Khaba and Snefru, perhaps in an effort to spread royal patronage and increase cooperation with communities outside of the capital. Although the evidence for the mid- to late 3rd dynasty is incomplete, the location of Khaba's RMC at Zawyet el-Aryan, the mudbrick RMC at Abu Rawash, stage E0 at Meydum and the MSPs show that the geographical scope of changes in RMC location reaches its maximum, 75 km, during the 50-70 year period that marks the end of the 3rd dynasty. First kings build in the region north of the capital connected to the Delta, and then the region south of it, between the Fayum and Middle Egypt; smaller satellite projects, known as the MSPs, are overseen across Egypt. As such, RMC building activities incorporate three key agricultural zones in Egypt, as well as other smaller trading centres. By bringing the building project to the provinces, different communities from the capital are integrated with others outside of it. It is significant that such a strategy unfolded immediately prior to the phase in which we see the most obvious involvement of the phyle system in the workforce, during the reign of Snefru.

Although incomplete, the evidence for the later part of the 3rd dynasty also suggests that building projects during this period remain relatively small in scale compared to earlier projects at Saqqara and especially compared to the later 4th dynasty RMCs. This could be a factor of building far from the capital. The RMC built at Abu Rawash in the floodplain, for instance, reintroduces mudbrick as the main building material and a rock-cut stone core calls for much-reduced use of stone-cutting. The Delta had an important economic role as the granaries of Egypt and, from the 1st dynasty, kings were establishing estates there (Lehner 1997: 228). The Delta's proximity to the Mediterranean Sea, the North African coast and the Levant also contributed to its importance. The first phase at Meydum may have entailed moving the experts from the capital down to Meydum. Whether the reduced scale of the Abu Rawash mudbrick project and its stylistic complementarity with the early Meydum E0 structure reflects a geographic division of labour groups and specialists under a single king or under two kings cannot be proven, but ought to be considered.

Although the end of the 3rd dynasty appears to be a 'murky' period, this may just be a bias of poor preservation rather than a truthful reflection of the situation. Whether the decentralising of RMCs was a side-effect of the central government's failures or a deliberate action designed to bring provincial elites further on board is not clear. The RMC as a platform for collaboration grows in importance after this period and remains central to later RMC building activities, which could point to a successful social strategy in the 3rd dynasty.

Phyles and Social Integration

The first major evidence for the use of phyles for building RMCs dates to Snefru's reign (Roth 1991: 119-24). Snefru oversees several building projects that depart significantly from previous ones in terms of their monumental scale. Most of the building took place at two RMCs 10 km south of the capital at Dahshur with a substantial amount of work carried out in the aggrandisement of a predecessor's RMC 45 km south at Meydum, and minor works in the aggrandisement of a MSP 10 km west of Meydum at Seila, at the edge of the Fayum (Pochan 1937; Lauer 1962b; Dreyer and Kaiser 1980; Swelim 1987b; Lesko 1988; Cwiek 1997, 1998). Snefru's building required unprecedented material consumption, a large, well-organised workforce, as well as specialists to oversee the extraction and the crafting and transportation of large volumes of fine limestone from Maasara, 13 km upstream to Dahshur primarily and 53 km Meydum. It is therefore no surprise that phyles appear in the material record of RMCs during Snefru's reign. Also, the location of Snefru's RMC south of the capital, is strategically placed at the head of a long series of estates Snefru possessed in Middle Egypt, from Meydum to just north of Abydos (in contrast, only four such estates are attested in the Delta). It is from these estates that much of the resources required for the building likely came (Hawass 2006). Building at Meydum and Seila meant building at the head of densely populated regions and major agricultural zones (Cwiek 1993; Para Ortiz 1996; Lehner 1997: 228). Snefru's presence in the region may have contributed to the provision of large groups of labourers and resources. His presence must also have brought about greater interaction with provincial elites, thus extending strategies his predecessors devised in to the mid- to late 3rd dynasty.

As discussed in Chapter 3, phyles are not an all-encompassing social system but are restricted geographically and socially. The four phyles involved in OK building activities probably belonged to a small elite that dominated the political scene of OK Egypt and were possibly centred around either Abydos, the ancestral home of the first kings, or Memphis, the new home of kingship, or both (Roth 1991: 61-74). While phyles are involved in both royal and temple institutions from the 1st dynasty onwards, evidence suggests that they are only integrated into royal building projects in the 4th dynasty (Roth 1991: 122). While the decline of evidence for phyles in the late 2nd and early 3rd dynasty may be tied to the lack of evidence that characterises this period as well as the type of projects that are smaller scale than the 4th dynasty ones, it could also mean that phyles had little involvement in the palace and the royal mortuary cult at the time, and it is only under Snefru that RMC building activities of the 4th dynasty prompted the re-adoption of this system.

The fact that Snefru was the largest consumer of stone has contributed to the view that the absorption of phyles into the building workforce was a practical solution to a practical problem of labour provisioning and management resulting from Snefru's desire to build at a truly monumental scale (Roth 1991: 119). Indeed, the evidence discussed in this chapter seems to support this. The phyle system is likely to have been useful for overseeing the transportation of fine limestone from the Tura-Maasara quarries, as it was later with Snefru's immediate successor Khufu's transportation of other hard stones such as granite. It is interesting that most of the blocks marked are fine limestone, brought from the first off-site quarry south of the capital at Maasara. Phyles may have been brought in to help with the size of the workforce, and especially the need for riverine transport of harder limestone from an off-site source. As phyle names appear at Meydum, the omission of the phyle name on the tools found abroad is not accidental; the tool may predate the time when phyles where fully integrated into the workforce (Roth 1991: 122). Alternatively, it could show the coexistence of two systems for organising workforces: gangs for the movement of groups of specialists abroad and at remote sites in Egypt and phyles from provincial elites for RMC building sites.

The fact that evidence for phyles in OK RMCs is always the same as that mentioned in other contexts, i.e. private funerary ones, probably indicates that phyles were supplied by the same groups of wealthy officials in high governmental positions, with each patron probably supplying a division (Roth 1991: 211). That tombs of wealthy officials show a high degree skill suggests that, as a reward from the king for their service in supplying the workforce, they could also use phyle members for their own private constructions, perhaps in addition to being granted certain valuable materials (Roth 1991: 211). Given the social context of these exchanges, one may ask whether monumental RMC building, as initiated under Snefru, revived a traditional allegiance system associated with provincial elites and encouraged its different components to collaborate or compete on the royal project. If Snefru's predecessors were successful in bringing the royal projects out to the provinces, the assimilation of phyles may have been the next logical step for the consolidation of royal power of Snefru himself by integrating existing social structures for service into the new institution of kingship.

Although this is at the limit of what one can say given the evidence, another significant development in Snefru's reign that may support such social strategies is the creation of pyramid cemeteries. Pyramid cemeteries mark a major shift from royal cemeteries being clearly separated from private ones to royal cemeteries being surrounded by members of the state, notably the royal family and high officials (Roth 1993: 48). It is interesting that this development occurs shortly after RMCs are built away from the capital (Roth

1993: 49). The subsidiary cemeteries at Meydum and Dahshur were built north of the royal tomb, potentially mimicking the layout of the necropolis at Saqqara (see Chapter 2; Roth 1993: 49, fn 52).

Co-option at Giza

Unlike Snefru, Khufu centred all his building activities at one site at Giza in the north near the Delta. As discussed, Giza offers an ideal logistical setting, being downstream from all off-site quarries. It had prime quality bedrock with a knoll core for the pyramid and easily accessible quarries providing prime material (see section 8.4). But looking at it in the context of earlier RMCs highlights the importance of Giza being close to the Delta for provisioning the workforce. In the same way that Khufu's father's building activities south of the capital placed his RMCs closer to the region where the bulk of his estates were (Cwiek 1997, 1998; Para Ortiz 1996; Lehner 1997: 228), Giza's location near the Delta may have been instrumental not only in the provisioning of the workforce required for Khufu's building project but also in forging good relations with communities in the Delta. This will be returned to in section 9.3 of this chapter.

The material evidence from Khufu's RMC indicates that Khufu employed a more specialist-driven workforce for the extraction, crafting and transportation of hard stones from distant quarries (Bloxam *et al.* 2009: 13). As mentioned in Chapter 3, recent evidence from these hard stone quarries indicates that small groups of highly skilled specialists likely travelled across Egypt from quarry to quarry, possibly with identities loosely structured around kinship ties in a way similar to today's specialist ornamental stone craftsmen in the region of Luxor (Bloxam and Heldal 2007: 316; Bloxam *et al.* 2009: 13). In particular, it is the Fayum quarries that appear unusual in having stone tools from almost every other known OK quarry landscape across Egypt, suggesting that the Fayum may have been the principle hub for hard stone specialists (Bloxam *et al.* 2009: 14). Despite this evidence for specialist mobility, it remains likely that full-time specialists belonged to local communities near quarries, as is suggested for the Fayum region (Caton-Thompson and Gardner 1934), the granite quarries at Aswan, and for the fine limestone quarry near the capital (Kelany *et al.* 2009).

While environmental factors, such as high floods, and the existence of adequate managerial infrastructure are important for enabling the bulk consumption of basalt, the phyle marks on the granite beams in Khufu's burial chamber suggest that the organisational system was expanded from limestone to facilitate the consumption of granite and manage that specific workforce. The large-scale consumptions of granite in RMCs from the start of the 4th dynasty until the end of the OK stresses the importance of the central government's relationship with its southern border, something returned to later in the final section of this chapter. Significantly perhaps, these 'material relationships' with more distant sources shifted by the end of the 6th dynasty, when the OK collapses, and efforts become focused on sources in the Nile Valley (Bloxam and Heldal 2007: 317). This shift can be cited as evidence to strengthen the case argued here of political relationships being negotiated through choice of location, materials and the latter's provenance and associated expertise groups. After Khufu, site changes are never again as significant as they were in the period leading up to his reign, showing a shift in strategy. This potential 'pull' of Giza, which may indicate its success, is visible in the location but also in material use and overall design of subsequent RMCs. After Khufu's RMC, all subsequent rulers' attempt to maintain Khufu's material consumption, consisting essentially of soft local limestone, fine limestone from Tura-Maasara and granite from Aswan. All three Giza RMCs comply with a Khufu-style design, mostly in their consumption of harder stones. Despite the scant evidence, the two off-site RMCs at Abu Rawash and Zawyet el-Aryan present almost identical programs that can be described as simplified versions of the Giza RMCs. Hence, one could describe the locational pattern as a nucleation around Giza, one that points to reuse of earlier infrastructures and communities for those not built at Giza. Giza may have acted as a specialist royal construction centre, offering many features that are comparable to a capital (Love 2000). It is significant that Giza is the only site where a worker's settlement of this scale is attested (Tavares 2008).

Phyle names are written on blocks used to seal two of Khufu's boat pits. This is the first evidence of a ritualised assembly and burial of a boat for the dead king (Khufu), a practice which is mentioned in a later spell from the Coffin Text (Roth 1991: 127). The four names are arranged cardinally, stressing once again the importance of spatial organisation of phyles. The possible archaic origin of the burial of Khufu's boat at Giza begs the question of whether phyles were also involved in the ritual burial of the 14 boats east of Khasekhemwy's enclosure at Abydos (boats that predate Khasekhemwy's reign, see figs. 6.16, 6.17, 6.18; O'Connor 1991, 1995; Ward 2006). The social context of boat building, based on evidence largely provided by these 14 boats, has already been discussed for the ED in connection with legitimisation of power, access to specialists based on apprenticeship, and control of resources (Ward 2006). Although none of the references to phyles during the reign of Khasekhemwy are the traditional names (Roth 1991: 209), it is interesting to ask whether phyles were involved with Khasekhemwy's enclosures at Abydos, Hierakonpolis and Saqqara and the degree to which they were therefore involved in those of previous kings, whether in building or servicing, or both. Phyle inscriptions and mason's marks would no longer be visible on mudbrick, if they were even required at all. If the incorporation of phyles in RMC building and the associated traces in the record are connected with large-scale stone building, and especially about tracing the provenance of a block of stone to a group, then there would be no need to provenance the brick, especially during Khasekhemwy's reign, when mudbrick production appears highly centralised. Absence of evidence does not mean that phyles, or similar social groups as those advocated for boat building (Ward 2006), were not involved in building or cult maintenance to some degree for early RMCs.

Finally, evidence that may support competitive building could strengthen the case for the importance of RMC building for socio-political ends. The fact that a phyle division was in charge of a block from its extraction to placement, that their work was organised spatially in a way that would conform to competitive building, and that in the reign of Menkaure phyles had names such as 'The Drunks of Menkaure' (Roth 1991: 137), points to the competitive nature of building that took place. As a comparison with mudbrick projects, it is worth using the example of the re-plastering of the mosque in the city Djenne in Mali for competitive ritual building, where the city-dwellers from the north of the town traditionally re-plastered the northern part of the mosque and those of the south its southern section (Marchand 2009: 290-4). Although this cannot be proven for the period under study, given the centrality of mudbrick architecture in the ED, it is worth asking whether a similar system existed then and/or whether spatial organisation of phyles visible in the later OK came from the earlier mudbrick tradition.

Following these developments, it is interesting that Shepseskaf departed from the Giza 'pull' and started a new trend of building much smaller RMCs centred around Saqqara, maintained throughout during the 5th and 6th dynasties. Shepseskaf did not have solar boats or a surrounding pyramid cemetery, showing an important departure from strategies that had worked so far. By the 5th dynasty there is an increase in the complexity of the phyle system, which is now clearly attested in the clergy running these complexes (Roth 1991: 77-88), possibly indicating a shift from an emphasis on involving these groups in building (reduced size) to less demanding priestly functions. In the light of the above, a major shift in strategy seems to have taken place in a way that highlights the importance of phyles and their integration in RMC building and the role these monuments played in early Egypt.

9.3. Symbolic and Ideological Implications of RMC Material Use and Location

Having addressed the major logistical trends of RMCs and their possible social consequences, it is now worth exploring whether greater attention to the ideological and symbolic implications of RMC location and material use might offer additional insights into the role these monuments played in the early 3rd millennium in Egypt. While the paucity of textual evidence for the period under study means we should be cautious about how much we can infer about symbolic meaning, studies such as those discussed in Chapters 2 and 3 demonstrate that religious concepts were often important contributors to a monument's design, and that sometimes symbolic considerations overrode economic ones in situations in which ruling elites were often manipulating meanings to legitimise their authority (DeMarrais *et al.* 1996; Posgate 1997; Baines 2000; Karlhausen 2000; Boivin 2004a,b; Scarre 2004a,b). The discussion below will build on previous understandings of RMC ideology that have been based primarily on the size, shape and layout of the monuments, by considering two particularly promising avenues: (a) meanings invested in the provenance and structural properties of materials, and how these meanings are visible in changing material use, and (b) the deliberate way in which the spatial patterning of RMCs might encourage the creation of wider sacred landscapes over time. While location has typically been considered before material use in preceding chapters, the order is reversed here for ease of discussion, starting with the specifics of material use at sites and moving to wider considerations of monument placement in the Egyptian landscape.

Provenance and Properties

As discussed throughout this thesis, material use in monumental architecture is often driven by practical and social goals, but also reflects symbolic concerns, with cultures often employing materials in monuments as 'pieces of place', so that their patterning expressed abstract worldviews and cosmologies (DeMarrais *et al.* 1996; Postgate 1997; Boivin 2004c; Owoc 2004; Scarre 2004a,b). This connection between material use and geographical provenance, which is particularly apparent later on in NK stone temples and royal statuary (Lacau and Chevrie 1977; Bryan 1993: 76; Karlhausen 2000), has been suggested in passing for the earlier use of mudbrick in funerary architecture but never explored further (Wood 1987). By the MK, the name of mines clearly indicate that they – and their materials – were seen as divine in nature (Aufrère 1991: 59-69; O'Connor 1998). The following discussion will focus on mudbrick, limestone and granite, the three materials consumed in the greatest quantities in RMCs. The patterns of material use in RMCs presented in Chapters 6-8 and discussed below supports the idea that Egyptians invested meaning attached to the source of a material in the material itself, enabling the ruling elite to engage with these notions as a means to express their relationship with the wider society and changing notions of kingship.

Cultivated Silts and Life Cycles

The results of my research suggest strongly that mudbrick was connected not only physically – through the provenance of its main ingredient – but symbolically to the agricultural valley and to notions of fecundity and cyclical change. Results also suggest that such meaning actively contributed to the delay of a larger-scale use of stone in RMCS (see also Wood 1987). Mudbrick was commonly made from ingredients from the cultivation, notably silty alluvium, water and organics, used principally for structures in the cultivation, including houses and palaces, and as birthing bricks for women to crouch on to facilitate labour (Kemp 2000; Goyon *et al.* 2004: 109-10). From the MK onwards, mudbrick was used for RMC and temple foundation rituals, and funerary rituals, indicating that mudbrick carried special symbolic meaning connected to the earliest stages of construction and to building protection (Spencer 1979b; Wood 1987; Aufrère 1991: 675; Hoffmeier 1993). In addition, the particular places where basalt was used in OK RMCs indicates that the stone's colour and fine texture was used because it was reminiscent of the colour and texture of silty mudbrick, suggesting that silt was invested with special meaning already (Spencer 1979b; Aufrère 1991; Hoffmeier 1993; Spence 1999; Goyon *et al.* 2004: 109-10). Silt, which was deposited during the inundation and enabled agriculture, was vital to the Egyptians (Goyon *et al.* 2004: 109-10). The Egyptian word for silt, *3ht*, which also refers to arable land, and *t3*, which seems to refer to the earth surrounding the body in the PT, are the two types of sediments used for brick making (Harris 1961: 199). The role silt played in Egyptian life is clearly attested in later divine iconography and texts (Griffiths 1982; Goyon *et al.* 2004: 110). Silt is still occasionally ingested today by women during labour as it is thought to help with the labour (Ikram 1998; Goyon *et al.* 2004: 105). Mudbrick's association with the cultivation and silt made it an ideal symbol of 'life' in a more general sense (Spencer 1979b; Wood 1987; Aufrère 1991: 675). Hence, abstract notions of life and rebirth symbolically expressed in mudbrick may have been an important aspect of its use in tombs in Egypt, facilitating resurrection of the deceased. These properties suggest why it continued to be used for wealthy private tombs when stone became more established (Porter and Moss 1979). It is from this perspective that changes in the materiality of RMCs that took place during Khasekhemwy's reign, are discussed.

Hierarchical Value

The patterns of mudbrick use in Khasekhemwy's RMCs and the recipes from Abydos and Hierakonpolis support the idea that (a) some degree of elite control existed over mudbrick production, hinting at a system of value based on access, expertise and ingredients, and that (b) a certain hierarchy of recipes may have existed with a preference for recipes employing fresh silty alluvium for public, ritual structures at least at Abydos and Hierakonpolis (see Chapter 6 and Appendix C). Indeed, distinctions based on perceived qualities of sediments are inherently likely to have existed in a society that employed mudbrick and relied on silt so widely. The wealth of vocabulary the Egyptians had for 'earths' supports this idea (Harris 1961: 199-210). Possible meaning vested in sediments and mudbricks is especially important to consider at a time when mudbrick was the main construction material across all types of structures, whether domestic or ritual, public or private.

Although further research is required, the compositional evidence of the mudbricks tested from Abydos and Hierakonpolis points to a hierarchy of recipes. Recipes containing as much fresh silty and chaffy organics as possible were preferred for bricks used in the more public, cultic structures, notably: Khasekhemwy's enclosure at Abydos; the second, more prestigious phase of his enclosure at Hierakonpolis; and the Temple (HK29A) at Hierakonpolis (see Chapters 6 and Appendix C). The recipe for the Temple at Hierakonpolis, though similar to the Fort's second phase and Khasekhemwy's Abydos enclosure, clearly stands out from others at the site. The seasonal availability of the remains of desert and aquatic fauna found in the temple strongly point to ritual practices being held in connection with the coming of the flood (Friedman 2012) in a way that suggests that bricks made with fresh silty alluvium may have been intrinsic to the monument's ritual function. It is possible that fresh, alluvial silty mudbrick recipes were preferred for certain structures because of the importance the inundation had in the Egyptian society, and by association, with the fertile silt deposited annually in the valley and the growth it enabled. The notions of renewal, resurrection and protection associated with mudbrick later on in Egyptian history may already have existed in the Late Predynastic and ED, and determined the patterns of material use visible in buildings at Abydos and Hierakonpolis (Aufrère 1991: 675; Goyon *et al.* 2004: 104-10).

Life Stages and the Human Body

In the light of the above, the treatment of the enclosures at Abydos may also support the idea that mudbrick had potent symbolic meaning drawn from its provenance, a meaning its inherent structural properties may possibly have strengthened, connecting it further to concepts associated with human life stages and/or the human body, especially with regard to the king. Mudbrick requires routine forms of maintenance (Boivin 2004a,b; Goyon *et al.* 105). In addition, as discussed in Chapter 3, studies show that because of earth's malleability, mudbrick and other earthen structures, both public and private, could be and were modified at critical times, such as marriage, birth or death (Boivin 2004a,b,c; Marchand 2009). Physical changes in mudbrick structures can mirror important changes in the social fabric and the material manipulation mudbrick offers is an ideal platform for the expression and (re-)negotiation of more abstract notions, such as a new social-political order within a family, or in this case a wider version of the family, a society (Boivin 2004a,b,c; Marchand 2009).

Prior to Khasekhemwy, all of the earlier enclosures were deliberately dismantled until only a few courses remained to signal their existence, and it seems plausible that this occurred at the moment a new enclosure was built (O'Connor 2009: 175). Mudbrick enclosures resembled palace architecture but are also a motif that goes back to much older pastoralist traditions, when enclosures made of perishables were built to protect cattle (de Trafford 2007; Bestock 2008). Although we are still unclear about the function of the monumental ED examples (see Chapter 2 and 6), they probably defined sacred spaces of social gathering and could be seen as symbols of containment in a patriarchal system and royal authority (de Trafford 2007), concepts that may also be reflected in the use of the cattle hobble to designate phyles. Given that the rituals that appear to have taken place within the enclosures seem to have had to do more with the living king (see Chapter 6; Friedman 2007; McNamara 2008), enclosures may have acted as highly visible monumental symbols of the living king and his role in society, in a way that evoked containment and protection in a more permanent material and visible manner by referencing earlier traditions. The uniform pattern of brick debris found either side of the foundations of the enclosure walls and the deposition of sterile white sand on the foundations suggest a form of ritual killing carried out either at the king's death or during his funeral (Adams and O'Connor 2008; Adams pers. com 2010). The sand used for this purpose at Abydos appears to have come from a very specific source in the Western Desert accessed via the Wadi Qa'ren, which may have been conceived of as the local gate to the next world (Richards 1999: 92). Sand was often used in funerary rituals owing to its association with the desert and the desert's association with death. Also, sand, especially sterile sand, and the colour 'white' in Egypt were commonly associated with purity (Aufrère 1991: 666-8), which suggests that the dismantling was a sacred act of purification, something that highlights the importance of these structures. Therefore the likely function of enclosures and traditional ritual killing of mudbrick enclosures at the king's death or funeral at Abydos suggests that these structures were symbolically connected to the king's life and may have acted as an extension of the king in a way that evoked his human existence and the impermanence of the human body. The mudbricks' ingredients are all from the fertile valley, the land of the living. Agriculture and earthen architecture requires regular, often annual, maintenance, or else both decay in a way that may be to some reminiscent of the human body (Aufrère 1991: 666-8; Goyon *et al.* 2004: 105).

Mudbrick Re-use and Royal Lineage

While the reuse of mudbrick is a very practical, cost-effective strategy at the monumental scale, this routine practice may also have enabled the ideological re-use or incorporation of earlier political, social and cultural traditions as well as reinforcing notions of cyclicality (Goedicke 1971: 11; Brysbaert 2011). Incorporating the old into the new, particularly regarding ritual structures pertaining to individual king and institutional royal ideologies of power, may be a way of establishing continuity and lineage, a notion fundamental to Egyptian kingship (Baines 1995: 3-49). In this regard, it may be of significance that mudbricks were being broken down in a pit within the enclosure precincts, near the northwest corner, rather than outside the sacred precinct where unsightly manufacture would be expected (Adams and O'Connor 2008). Hence, although this is at the limit of what the evidence enables us to confirm, if an ED ruler typically dismantled his predecessor's enclosure to build his own, we might anticipate that it was both common and advantageous for him to reuse mudbricks from the old enclosure to make the new ones. If mudbrick was connected to notions of life and cyclicality it is possible that it helped express materially more abstract notions of at least a conceptual or ideological life, or blood/kin-like lineage that is so important in royal succession (Baines 1995: 129; 1997). It is interesting that reuse of material and structure is continued with Khasekhemwy's successor Djoser's stone RMC at Saqqara, hinting at continuity in practice of reuse (Lauer 1962: 82-98; Stadelmann 1985, 1996; Dreyer *et al.* 1998). A useful later example of monument reuse is also provided by later MK RMCs built of mudbrick and stone, whose builders went out of their way to collect material specifically from Khufu's RMC at Giza to build at Lahun. The patterns of reuse of the blocks from Khufu's RMC point to a deliberate placement in key parts of the structure that indicate a sense that the re-used material mattered for symbolic reasons (Goedicke 1971: 11).

In the light of the above, it is interesting that while Khasekhemwy's tomb and enclosure are very much embedded in the local cultic landscape at Abydos, they also depart from earlier tradition in that his enclosure was not dismantled and his tomb referenced (through stone use and layout) the 2nd dynasty stone architecture of Saqqara (O'Connor 2009: 157; also section 9.3). The reasons why Khasekhemwy's enclosure still stands remain unknown; however, Adams and O'Connor (2003: 84) suggest that it was the result of its sheer size. Indeed, the dimensions of the walls, the presence of a perimeter wall (which is unique to Khasekhemwy's enclosures), the use of grass matting to strengthen the walls, and radial bonding to strengthen the corners indicate that monumental scale and permanence was intended from the start. Unlike previous enclosures, this one was built to last beyond the individual life of the king. Such a development in royal funerary building practice implies a deep shift in royal ideology, where kingly notions of monumentality and permanence are now more directly intertwined with stone, in a way that pre-empts the conceptual developments traditionally ascribed to his successor, Djoser, via his stone RMC at Saqqara in the north (O'Connor 2009: 177).

Local Funerary Cult at Abydos: negotiating transformation?

If we consider the Abydos enclosures in the wider local cultic landscape that was dedicated to the funerary god Khentimentiu, guardian of the West, then their ritual treatment appears especially strategic. The symbolic properties of mudbrick enabled it to play a major role in ritual negotiation of a major, critical event: the death and re-birth of kings. The royal tombs were placed by the entrance of the Wadi Qaren, with their 'back entrances' orientated toward the Wadi potentially seen as the gateway to the land of the dead, (Richards 1999: 92; Adams and O'Connor 2008) and the front ones orientated toward the natural processional way (the wadi palaeofan) that linked them to the associated enclosures built behind Khentimentiu's temple by the palaeofan's entrance. This positioning and the apparent acts of ritual dismantling suggest that the ruling elite used their monuments to articulate complex notions surrounding a momentous event that had the potential to threaten the institution of kingship: the death of a king. It may be significant that while other ED provincial shrines are built with a variety of materials such as perishables, stone and brick (Kemp 1989: 65-83; O'Connor 1998), the local shrine dedicated to Khentimentiu was built of mudbrick and that one of the main ritual practices carried out during this period involved throwing silt or clay knots into a pit to burn or permanently transform them (Petrie *et al.* 1903: 5-10). Although this remains tentative, the evidence points to rituals associated with soil symbolism and the transformation of malleable silt/clay. By placing their RMCs close to the local funerary cult dedicated to Khentimentiu, Egypt's first kings worked within but also contributed to the creation of a funerary landscape that was key to notions of kingship. It is significant that Khasekhemwy retains but also departs from this tradition. The properties of mudbrick may have eventually contributed to the material's demise in RMC construction, suggesting that material patterns may also have been part of a dynamic symbolic discourse.

Stone Provenance

Provenance and the meaning attached to the source of stones in the Egyptian landscape may also have been key for the particular ways stone was deployed in RMCs. Considering the immediate proximity of the Tura-Maasara limestone quarries to the capital, it is possible that the limestone from Tura may have come to be associated with the capital and the north of Egypt as it almost certainly was when used for the northern part of the New Kingdom temple of Karnak at Luxor pylon mast bases in the northern part of the Karnak temple at Luxor (see section 4.4; Barguet 1962: 54; Lacau and Chevrie 1977; Bryan 1993: 76; Karlhausen 2000). Such an association may have been facilitated by the stone's white colour, given that limestone was known as the 'white stone' and the capital *Inb Hedj* as 'White Walls' (Harris 1961: 69-71; Aufrère 1991:

695; Malek 1997: 91; Jeffrey 2010). While the latter may have initially referred to a whitewashed mudbrick wall encircling the settlement, it may also have referred to the white limestone cliffs, either side of the capital at Saqqara and Helwan, that quarrying activities eventually reworked and exposed (Jeffreys 2010; Klemm and Klemm 2010: 12-26). Although this cannot be proven unequivocally, the white cliffs of Saqqara and Tura-Maasara, and their material, may nevertheless have become a symbol of the capital and the north. The patterns of use of limestone and the placement of certain monuments support this notion. Although the use of limestone in Khasekhemwy's tomb at Abydos may in part respond to structural requirements, the parallels drawn with Khasekhemwy's tomb and the earlier rock-cut RMCs at Saqqara and the fact that the rarer material was reserved for his burial chamber suggest that in addition to evoking notions of the heavens, purity and permanence, white limestone was symbolising a political core, the capital in the north. Later, at the start of the 4th dynasty, when Snefru brought for the first time large amounts of fine limestone to his RMCs in a more central region 40 km upstream from the capital, this was ndeniably an economically impressive act, but it was also one that had the added effect of moving a well-known feature of the capital in the north to a different region. The placement of Snefru's monuments expresses a desire to mark Middle Egypt and the Fayum with the stamp of royal authority (one RMC at Meydum, two at Dahshur and the likely aggrandisements of the MSP at Seila) and using the capital's limestone may have aided this effort and was a practice built upon by subsequent rulers.

The rapid shift of stone acquisition from local to national scale under Snefru, which was likely tied to the exhaustion of the fine limestone source at Meydum and Dahshur, was rapidly expanded upon under Khufu because the infrastructure and mindset required were now in place. The shift in scale of stone acquisition may also have enabled a new discourse of state ideology that brought key regions into the centre. Khufu uses large amounts of basalt from the Fayum and granite from Aswan. While basalt consumption was dependent on high floods and adequate managerial infrastructure (Harrell and Brown 1995; Bloxam and Storemyr 2002; Boxam *et al.* 2009) it is significant that such consumption was achieved at a time when RMC placement shifted north, probably for logistical reasons (downstream transport) right after Snefru was highly active in Middle Egypt and the Fayum regions. Khafre replaced the use of basalt with the use of travertine, which is also from Middle Egypt. Using stones from Middle Egypt/Fayum in the northernmost RMCs was therefore the mirror strategy to Snefru's use of northern limestone in Middle Egypt. Using stones from key regions may have helped to map out materially, with highly visible markers (RMCs), a growing socio-political landscape in a manner that highlighted how different regions, especially important border zones (Fayum and Aswan) were key components of the centralised state. Such nationwide acquisition patterns were further maintained with granite. As the patterns of use seem to stress the importance of this region, a special appraisal of the stone is given below.

Granite Provenance

The use of granite in RMCs stands out from that of other stones in that it is (a) the first stone to be introduced into RMC architecture and (b) the only hard stone consumed consistently in vast quantities from the 4th dynasty onwards. Initially granite was restricted to the interior of RMCs (Den, Khasekhemwy, Djoser), but when granite consumption increased dramatically in RMCs from Khufu's time onwards, the material also became more visible from the outside and to the ordinary viewer. It is argued here that the stone was used to convey notions of strength, protection and transformation, but it may also have taken on unusually important and distinct meaning in RMCs due to its provenance (Aufrère 1991: 702-3; Spence 1999; Baines 2000: 35-6; Karlhausen 2000: 46). From the OK, granite was known as *maatj*. Early 4th dynasty inscriptions from Meydum qualify it as 'the beautiful stone destined for *maatj*-vases' (Petrie *et al.* 1910, pl. 13), suggesting that the term *maatj* was probably derived from the type of vessel into which granite was most commonly shaped (Sethe 1933: 878; Harris 1963: 72) or vice-versa. In the OK, the name for granite was also used in the expression for the landscape of Elephantine (Sethe 1933: 878) and from the MK (18th dynasty) onwards *maatj* is commonly used with an indication of provenance and designated as *maatj 3bw* 'the stone from Elephantine' (Petrie 1987: 12, 4; Gardiner 1935: 7; Harris 1961: 73; el-Sayed 1974: 41; Aufrère 1991: 706-7, fn. 77). Later in the Ptolemaic period, the quarries at Aswan were known as 'the great vein of Elephantine' (Aufrère 1991: 706-7; Dümichen 1865: 67) and 'the great residence of granite' (Aufrère 1991: 706-7; Gautier 1925: 68) in a way that clearly links the stone with the island of Elephantine, even though the quarries were on the mainland. If one is to get close to understanding the use of granite in RMCs, these textual mentions that show granite's specific association with *Ibw* or Elephantine (even if some of the evidence is of later date) suggest the validity, more widely, of looking at provenance and symbolic meaning.

Aswan was host to one of the oldest provincial temples known in Egypt. The shrine lay on the southern tip of the island of Elephantine, a few kilometres north-west of the main granite quarries, at the heart of a region dominated by granite at Egypt's southern border (Seidlmayer 1996a,b). Evidence indicates that the shrine site's earliest occupation dates to Naqada I (c. 4,000-3,850 BC) and that the location was already the setting for cultic activities. The original shrine consisted of a simple grotto formed by two massive, naturally occurring granite boulders, to which, from the ED, walls and an altar made of mudbrick were added. By the 3rd dynasty, the temple was clearly dedicated to the goddess Satet. Whether this was the case in the earliest phases is not entirely certain, but the existence of a deep shaft connecting all the later temple's phases with the earliest shrine floor strongly points to the importance of continuity between all phases (Wells 1992; Wilkinson 2003: 165). The long period of cultic activity at the shrine and temple on Elephantine highlights the cult's importance (Franke 2001: 465-6). The fact that by the 2nd dynasty a fortress had been erected nearby and by the 3rd dynasty a provincial step pyramid, both markers of the state, shows that Elephantine was important for the Egyptian state in this period (Seidlmeyer 1996a,b; Bussman 2011, in press). It may also be significant that these buildings were erected just before granite consumption dramatically increased and became more visible in RMCs. All the above and the fact that the Satet temple was not taken over by kings – unlike others – until the end of the OK, suggests that here royal power and the local groups cohabited (Seidlmayer 1996b).

Satet (or Satis) is attested as early as the 1st dynasty on inscriptions found on stone vessels buried under Djoser's step pyramid at Saqqara, a large portion of which were reused and of earlier date (Lauer 1959). In the 6th dynasty, spells from the Pyramid Texts, which are also much older, state that Satet purifies the dead king by pouring water from Elephantine onto him from four vases (which may be connected to the above-mentioned *Maatj*-vases; Valbelle 1981). Later, Satet was seen as protector of the southern frontier and associated with the inundation and the southern star Sirius or Sodpet in Egyptian, which means "bringer of the New Year and the Nile inundation" (Wells 2001; Wilkinson 2001: 164). The rising of Sirius on the eastern horizon was a momentous event that announced the beginning of the inundation and the start of the agricultural year (Wells 1992, 2001; Franke 2001: 464-5). This event was so important that it was marked by a celebration called "Feast of the Nile Flood" which took place in the temple of Satet, which itself was aligned to the rising of Sirius. It may be significant that the island was the first place in Egypt from where the floodwaters could be monitored, and apparently it was possible to hear the rising waters before they could actually be seen by means of a drill hole placed under the altar in front of the shrine. Potentially further supporting a connection between Aswan granite and the rise of the flood is that fact that the floodwaters in Egypt were construed as being red-coloured (Pinch 2001: 182-4). Textual evidence, mostly spells, indicates that many red things, such as fire, the inundation waters or the menstrual cycle were seen as both good and bad, but that their danger could become mitigated if handled correctly through ritual (Pinch 2001: 182-4). This is reminiscent of the Egyptian view of the flood as having the potential to be either beneficial if too high, or devastating if too low (Butzer 2001b). The symbolism behind the patterns of use of granite in RMCs could be explained as a means to orchestrate the resurrection of the dead king and in so doing ensure a good flood, both of which were connected in Egyptian thought (e.g. for early Egyptian kingship: Hassan 1997; Bard 2002). The fact that so much of the architecture of RMCs (e.g. orientation and slope inclinations) is based on measurements derived from observations of the night sky, which was the basis for timekeeping and used for agricultural purposes, shows how important celestial patterns were, especially those associated with the flood. The inundation embodied the rhythm of life, the passing of seasons, growths and harvest, life and death. Although later texts must be used with caution, it is significant that the analysis of the archaeological evidence supports what Late Period textual evidence says regarding black granite (which was the material of choice for the sarcophagus of certain 4th dynasty kings) being associated with the rise of the flood (Aufrère 1991: 702-3). This explains (a) the early use of both black and red granite for non-structural purposes, something seen again later but at a limited scale, perhaps because of black granite's rarity (Den's burial chamber), (b) the initial placement of black and red granite at the heart of the tomb (Den's burial chamber), and (c) when logistically possible, the use of granite on the exterior of pyramids, making it more visible, for the northernmost RMCs. If a stone came to be associated with such concepts through provenance and possibly colour, it would make sense for it be used at the heart of tombs built to resurrect Egypt's kings. Placing the stone on the exterior may have been an important development, making such notions visible to all.

It is significant that the construction of the northernmost OK RMCs, which are the furthest from the original source of granite, coincides with the increase in consumption and appearance of granite on RMC exteriors. After 200 years of hiding within the heart of these monuments, granite becomes conspicuous in outward displays. By so doing the rulers and builders not only demonstrated great logistical and engineering abilities; by working closely with local granite specialists, they also symbolically brought the southern stone to the far north in great, externally visible quantities. Although the case necessarily remains speculative in the absence of contemporary Egyptian explanations, the use of granite in RMCs may have served several symbolic roles: (a) helping resurrect the dead king because of granite's connection to the rising of the flood in a way that rapidly also protected him physically because of the stone's strength (from Djoser onwards) and (b) eventually helping highlight (Khufu onwards) concepts of the south in the north, and possibly more particularly of Egypt's southern border region, the seat of power of which was at Elephantine.

Mudbrick into stone

As mentioned earlier in this section, whereas the physical properties of mudbrick helped support an ideology that was important to Egypt's kings and determined the material's use in architecture, the same physical properties may have led to its demise in RMCs. Still, evidence suggests that certain perceived properties and their associated value remained important and that these may have been transferred to stone. Indeed, colour orchestration in stone RMCs suggests that there was more continuity in practice with earlier mudbrick architecture than traditionally thought. In the same way that the use of mudbrick in Khasekhemwy's RMCs at Abydos was very much informed by stone architecture, the use of stone in Djoser and later RMCs was very much informed by mudbrick architecture, for example in the proportion of the blocks, which is similar to that of mudbricks. While the height of the stone blocks was determined by the width of the limestone slabs quarried, the length and width were not (Klemm and Klemm 2010) and these referenced mudbrick. The heavy reliance on mortar in the first instances of Djoser's mastaba (M1) reminds us of the use of mortar in mudbrick construction. Basalt floors in RMCs echo brick pavement, as seen in Djoser or Snefru's RMCs (Chapters 6 and 7). The use of fine limestone to protect poorer quality masonry echoes the plaster and whitewash protecting mudbrick structures, suggesting the stone's protective properties played practical and symbolic roles in architecture. Later, the use of pink/red granite for lower parts of walls echoes the use of ochre for the lower earthen walls portions, as seen with the enclosures of Peribsen and Khasekhemwy. A more common example is the imitation of wood or other organics in stone architecture (e.g. columns that represent wooden beams in Djoser's RMC). Roth (1998) argues a similar integration of the old in the new with regard to OK royal funerary architectural form, whereby earlier shapes are embedded in latter ones, possibly acting as a sort of architectural history.

Site Placement and Wider Funerary Landscapes

Before concluding this section, three patterns regarding the placement of RMCs are worth commenting on. These suggest that the placement of monuments was potentially important and manipulated as a means to communicate royal ideology to the wider population. While pragmatic, economic and social concerns all undoubtedly contributed to placement of RMCs, symbolism, which is recognised as important, has hardly been expanded upon in previous discussions (see Chapter 2). Based on the degree of religious symbolism that went into the shape and layout of RMCs and the fact that, unlike private tombs, each RMC is systematically placed on the west bank, the bank of the Dead, it is argued here that a more specific religious symbolism may have contributed to the shift from traditional centres to an expansion of the royal necropolis.

The patterns that emerge from the placement of early RMCs at Abydos and Saqqara tentatively suggest that it was important to place early RMCs near key centres and embed them in a pre-existing local cultic landscape. One way to understand Khasekhemwy's building program is that each structure marked a centre that was key to the unification of Egypt (see Chapter 6 and section 9.1). Khasekhemwy builds his RMC on the burial ground of Egypt's first kings at Abydos where he follows the local tradition but departs from it in a way that clearly references Saqqara's. He also builds at Hierakonpolis, his likely power base, and possibly the Gisr el-Mudir at Saqqara by the capital. Khasekhemwy's immediate successor Djoser returns to the 2nd dynasty necropolis at Saqqara where his immediate successor Sekhemkhet also placed his monument. With the exception of Khasekhemwy's 2nd enclosure at Hierakonpolis (which marked a centre important to him and later kingship), all three rulers continued the 1st and 2nd dynasty traditions by placing their RMCs at the two traditional cemeteries, the first attached to the funerary cult of the jackal god Khentimentiu, the second to the capital and possibly the creator and mortuary god Ptah, patron of craftsmen and architects, with such highly visible monuments.

The final shift from Abydos to Saqqara suggests that a deeper development in royal religious ideology was being articulated in royal funerary practice. In the light of the treatment of Khasekhemwy's RMC at Abydos, which was deliberately modified to evoke architectural developments at Saqqara, the shift may have been tied to political developments already in Khasekhemwy's reign and instigated in the earlier part of the 2nd dynasty. What is most notable with Djoser's RMC is the stone craftsmanship. Later, the major cult centre at Saqqara was clearly dedicated to Ptah. Although the evidence for this cult at Memphis is limited for the period in question, that which exists suggests that the cult was already in place (Wilkinson 1999: 293). Ptah was a funerary god, like Khentimentiu, but was also the patron of craftsmen and architects. Hence, it is significant that the royal tombs were embedded, as they were at Abydos, in a local religious landscape that brought certain notions of craftsmanship to the forefront of royal cultic discourse expressed in the placement and material choice of RMCs.

The other trend that deserves mention started subsequently, with Khaba. By leaving Saqqara, Khaba instigates, knowingly or not, systematic site change in the north of Egypt that is maintained with all RMCs until the 5th dynasty. He also instigates a process of expansion of the royal necropolis that rapidly reaches its maximum breadth. While this may have been the unintended consequence of purely practical concerns, rapidly the placement of the monuments contributed to the creation of a monumental royal funerary landscape. Although the succession of kings and RMCs is debated for the 3rd dynasty, the sequence proposed in this thesis (see Chapter 2) suggests that once systematic site change had been established, the northern and southernmost boundaries of the OK pyramid field are rapidly established with the RMCs of Abu Rawash in the North and Meydum (phase E0) in the south. The two RMCs appear to work together, locationally, materially and in terms of the design of their internal apartments (see Chapters 6 and 7). The evidence might support the notion of a need to expand from the core, capital region and create a highly visible royal necropolis that goes beyond the confines of a single site, unfolding at a scale that is closer to expressing newfound aspects of kingship and the state system. Although this remains speculative, the evidence that the northernmost RMC at Abu Rawash employed mudbrick and the southernmost at Meydum employed stone, as a result of material accessibility in their immediate environment, seems to reflect a reverse relation of material use and placement. Likewise, the MSPs may be seen as an extension of the RMC acting as a symbol of royal authority beyond the capital.

A final note on the placement of monuments concerns patterns of site reuse that characterise the majority, if not all, the 4th dynasty RMCs. The evidence suggests that

Snefru likely reused an earlier structure of the 3rd dynasty at Meydum. Equally, written evidence suggests that a 3rd dynasty RMC existed at Dahshur. The archaeological evidence indicates that Snefru reused an earlier mudbrick enclosure from an earlier RMC for the valley temple of his Bent pyramid (Seidlmayer 2006; Arnold 2013; see Chapters 6 and 7). Whether the structure Snefru reused and the one mentioned in the inscription were the same is unknown. Site reuse is also seen in the majority of the 4th dynasty RMCs. As discussed in Chapters 6 and 7, evidence suggests that Khufu's move north was in part logistical, with each RMC conveniently placed downriver from all off-site sources of building material. It has also been argued that the growing importance of the sun cult and the desire to get closer to its centre at Heliopolis prompted this movement (see Chapter 2). While there is no evidence that Giza was the site of an earlier RMC, given that both before and after Khufu, each 4th dynasty RMC that is not built at Giza reuses 3rd dynasty RMC sites with Djedefre at Abu Rawash, the Great Pit at Zawyet el-Aryan and Shepseskaf at Saqqara (Lehner 1985b; Martin 1997; Der Manuelian 2009), reuse should not be excluded for Giza. While site reuse may have served logistical ends, it may also have been symbolically charged with the 4th dynasty rulers largely working within an established framework set by the 3rd dynasty rulers, one that they could expand, or rework, by marking the landscape with more visible monuments and more off-site materials.

9.4. Summary

This chapter synthesises the implications of the major locational and material trends visible in RMCs from the late ED to the 4th dynasty. I have marshalled evidence to show that monumentality of the 4th dynasty RMCs, traditionally discussed in terms of overall consumption of volumes of materials, benefits from being refined by greater attention to earlier undertakings, and especially the earlier mudbrick projects. The overall patterning of RMCs suggests that many of the later developments, normally considered inherent to the use of stone RMCs, were rooted in Khasekhemwy's smaller scale mudbrick projects. His building activities were far more instrumental than has been acknowledged. In addition, I argue that the period of internal colonisation that followed Khasekhemwy's reign, in the 3rd dynasty, was essential in providing the necessary impetus for the larger 4th dynasty projects (Parra Ortiz 1996). As such, RMC building was instrumental in more ways than traditionally thought (size, shape, layout) in helping to establish notions of statehood through the complex interplay of logistical, social and symbolic notions attached to choices of location and material. Locational and material selection helped express both the identity of existing sub-regions and their sub-groups, and the growing central power.

CHAPTER 10
CONCLUSION

This thesis has considered a series of royal mortuary complexes built in Egypt during a key 200-year period of socio-political transformation. It has demonstrated how a more theoretically informed, landscape- and materials-based approach can assess the degree to which the building of these monuments contributed to the successful consolidation of the state. While suggestions have been made about the socially-active role of, say, 4th dynasty RMCs (e.g. Lehner 1997), no study has specifically treated the role that the choice of location and building materials played in this regard, and especially not for the shift between the ED and the OK.

The main findings of this research were summarised thematically at the end of the previous chapter. They demonstrate that by (a) bringing together both locational and material data, (b) considering both the mudbrick and stone RMC traditions, and (c) giving due attention to both logistics and symbolism, it is possible to gain a better perspective on the socio-political scope of building RMCs. By seeing these monuments as ongoing building projects, this thesis helps bring into sharper focus traditional assumptions about the shift from the ED to the OK and helps flesh out patterns of continuity and change. In so doing, it allows for a better contextualisation of later OK developments and a better understanding of the interplay between place, material, people and state. This thesis also shows how building projects enabled the integration of older norms into newer ones, and that continuity exists under the veneer of what was traditionally seen as change or rupture.

Just as important, this study also shows how it is possible to gain more insights into mudbrick architecture by providing a new and simple field method for the scientific analysis of mudbricks, which can help direct targeted excavations, while also working within current limitations on the movement and exporting of scientific samples. These mudbrick analytical techniques enable deeper insights into the material record that remains at the heart of the Egyptian socio-cultural landscape, and help us draw fresh information concerning the organisation of the mudbrick workforce to help counteract the existing emphasis on stone. This thesis also shows the benefits of combining small, site-scale analysis with a larger landscape-scale one.

There is, of course, a whole range of ways in which further work along these lines might proceed. For example, it would be interesting to expand the temporal and spatial framework to incorporate earlier ED RMCs, those of the later OK, and those of the MK (the latter of which were stone-clad mudbrick pyramids); and, for comparative purposes, it would be valuable to consider developments in Egypt alongside those in other cultures with similar monumental earthen and stone architecture. With regard to the mudbrick analysis, it would be useful to expand the sample size and pay closer quantitative attention to the spatial distribution of micro-scale variability in different parts of the same monument. In particular, it would be helpful to incorporate all of the mudbrick structures found in the RMCs rather than only focus on Khasekhemwy's. In addition, expanding beyond royal, public architecture to incorporate samples from contemporary domestic structures would provide a further point of contrast. Lastly, if circumstances permitted, it would be important to add a further dimension to the mudbrick analysis by comparing existing results with brick thin-sections. In any case, regardless of these future opportunities, the research discussed in previous chapters hopefully indicates new ways in which a location- and materials-driven approach can offer useful insights on otherwise seemingly well-known Egyptian monuments.

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LIST OF JOURNAL ABBREVIATIONS

AAnt – American Antiquity

ASAE – Annales du Service des Antiquités Egyptiennes

BACE – Bulletin of the Australian Centre for Egyptology

BIFAO – Bulletin de l'Institut Français d'Archéologie Orientale

BMSAES – British Museum Studies in Ancient Egypt and Sudan

CAJ – Cambridge Archaeological Journal

CRAIBL – Comptes Rendus de l'Académie des Inscriptions et Belles-lettres

DE – Discussions in Egyptology

EA – Egyptian Archaeology

GM – Göttinger Miszellen

JARCE – Journal of the American Research Center in Egypt

JEA – Journal of Egyptian Archaeology

JNES – Journal of Near Eastern Studies

JSSEA – Journal of the Society of the Study of Egyptian Antiquities

MDAIK – Mitteilungen des Deutschen Archäologischen Instituts

SAK – Studien zur Altägyptischen Kultur

WA – World Archaeology

ZÄS – Zeitschrift für ägyptische Sprache und Altertumskunde

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